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Financial Liberalization and House Price Dynamics in Europe

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Abstract

This paper investigates the determinants of house prices in a sample of European countries over the period 1970-2004. Focusing on the role of financial liberalization, we find that it has mainly affected the short term dynamics of residential prices. In particular, the impulse effects on house prices of income and mortgage debt have become smaller. On the other hand the effects of interest rates, past house prices and, to a lesser degree, stock market have strengthened. In other words, there seems to have been a certain "de-linking" of short term house price dynamics from income, whereas the housing market may have become more similar to a financial asset market, with interest rates and expectations of capital gains playing a more prominent role.

Keywords: house prices, financial liberalization, cointegration, error correction mechanism.

JEL Codes: C2, G1, R21.

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1. Introduction

House price changes in Europe have been largely attributed in recent years to developments in the financial markets, namely the fall of interest rates and the easing of credit constraints following financial market liberalisation. Consequently, the return to less favourable credit conditions has been feared to trigger a sharp downturn in the housing market in Europe as in the U.S. However, despite widespread conviction of the importance of financial factors on house price dynamics, the empirical evidence is relatively thin and often difficult to interpret, especially when it comes to studies outside the U.S. and the U.K.

The earlier cross- or multi-country studies of house price dynamics focused primarily on the interest rate channel (see for example Kennedy and Andersen, 1994, Englund and Ioannides, 1997, Kasparova and White, 2001). For the most part, interest rates (or the user cost of capital) were found to have a statistically significant, though quantitatively limited impact on house prices. Other financial variables and, in particular bank credit, have also been introduced in some recent empirical country-specific and cross-country studies, on the grounds that there may be credit rationing. The role of credit was explored early on in country specific models, particularly for the U.K. (see for instance Hendry (1984) and Meen (1990)) and was also taken up in the more general discussion on the determinants of asset price dynamics. A certain coincidence in recent years between credit cycles and house prices in countries other than just the U.K. has brought the possible relation between the two back into the limelight. Tsatsaronis and Zhu (2004), IMF (2004), Lecat and Mésonnier (2005), Ott (2006) and others have explored the role of bank credit in house price models covering several countries.

In general, credit quantity variables in these studies turned out to be statistically significant, though, in many cases endogeneity may have been an issue of concern.[1] The construction of alternative measures of "credit availability" or "excess liquidity", apart from raising additional methodological and measurement issues, has not been empirically very successful. From the theoretical point of view, the general lack of a well defined theoretical framework makes the interpretation of the results more difficult. Perhaps even more to the point, there seems to be a significant gap between, on the one hand, the theoretical discussions on structural changes in the mortgage markets and the financial system in general and, on the

[1] Hofmann (2003) examined the two-way relationship of property prices and bank lending in a sample of 20 countries. His evidence suggests that the long-run relationship runs from property prices to bank lending, while in the short run causality may be running both ways. See also Hofmann (2004).

other, the little emphasis the empirical literature has placed in detecting any changes over time in the relation between house price dynamics and financial variables. Noticeable exceptions are provided by Muellbauer and Murphy (1997) who argue that financial liberalization of mortgage markets led to notable shifts in house price behaviour making real interest rates relatively more important. A similar argument has been made by Iacoviello and Minetti (2003) who have estimated that in Finland, Sweden and the U.K. the sensitivity of house prices to short term interest rates has increased over time, probably as a result of the process of financial deregulation.

This paper takes another look at house price dynamics and their relation to financial factors, and attempts to close some of the gaps in the existing cross-country empirical literature. First, we briefly consider what the theory has to say about financial factors in household housing investment decisions. We argue that apart from the interest rate channel, there are likely to be other channels through which financial conditions affect household's housing decisions. Non-interest rate financial factors, in particular, are expected a priori to have most of their impact in the shorter term dynamics of housing demand. We then present an econometric analysis using panel data within a traditional error correction mechanism (ECM) approach, and assess the importance of macroeconomic and financial variables for house price dynamics in the short and long run. Our data set includes most of the commonly used explanatory factors of house prices, including some supply side variables that are often absent in empirical research. The sample covers 11 EU countries, starting from the early 1970s to 2004 (annual data). As a final step, we look for indications that suggest that the financial liberalization process has affected house price dynamics and the relation between financial factors and house prices.

In short, our results suggest that house prices are cointegrated with disposable income, interest rates and mortgage debt, whereas we have problems identifying with certainty the role of other variables, notably that of demographics and housing supply. Financial factors seem to play an important role in short term house price dynamics. When we then explore changes in the estimated coefficients in the pre and post periods of mortgage market liberalization, we find that the main differences between the two sub-periods concern the short run dynamics. The impulse effect of both income and mortgage debt falls in the more recent period, compared to the period prior to liberalization. On the contrary, we find that the impulse effect from mortgage interest rates and stock prices increases significantly in the more recent period, as does also the "persistence" of house prices. Loosely speaking, the housing market would seem to have become over time more similar to a financial asset market, where the market interest rates and expectations of capital gains play a more prominent role in household decisions. To the extent that our relatively short time series allows us to say, short term house price dynamics seem to have become more complex in the more recent period, possibly because of the role capital gain expectations have come to play.

Section 2 provides a brief theoretical discussion of the role of financial factors for housing demand. After a preliminary examination of the data and a discussion of the baseline specification in Section 3, the empirical investigation is then carried out in two parts. In Section 4 we consider a reduced form panel data model for the whole period. The aim is to check and, where possible, improve upon the standard empirical relation between house prices and financial factors. Section 5 looks at possible indirect changes of financial liberalization on the short and long run determinants. Finally, Section 6 concludes.

2. Financial Factors in Housing Decisions

Textbook analysis of housing decisions is based on simple assumptions about the financial side, namely that individual households face either a perfectly elastic or a perfectly inelastic supply of credit. The former is equivalent to the Jorgenson type of model in corporate investment. The perfectly inelastic credit supply (when debt or the debt-asset ratio exceeds a certain level) is instead the building block for the familiar financial accelerator models. Though not particularly realistic, both assumptions simplify considerably the modelling of household decisions and each provides an explanation for including either price (interest rate, user cost of capital) or credit quantity variables in empirical relationships.

A more subtle difference between the two is that the Jorgenson type of models are essentially models about stocks or long run plans, while the financial accelerator models are about flows or the short run adjustment from one optimal stock position to another. This point is shown formally in Annex 1 where we consider a somewhat more realistic credit supply function that combines a perfectly elastic portion with an upward-sloping part. The former captures the “going” mortgage interest rate, i.e. a rate closely linked to the return of other assets and charged to the most credit worthy households. We can think of this as the mortgage interest rate “floor”. The upward-sloping part can be thought of as a rising premium paid by less credit worthy households with higher debt-asset ratios. A premium of this type may take the form of a higher mortgage interest rate or a non-interest rate cost incurred for example when

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the household is asked for extra collateral, fees, an additional insurance or is faced with less convenient contractual mortgage terms. At the limit, credit may be rationed (for example when the debt-asset ratio is around 1), at which point the premium function becomes perfectly inelastic.

As might be expected, the introduction of the above credit supply function combines elements of both the Jorgenson type of investment models and the financial accelerator models. Households' housing optimal plans depend both on the "going" mortgage interest rates and on the credit standards and credit constraints that affect the above mentioned premium function. Perhaps more interesting for the empirical work and less obvious a priori is the suggestion that one needs to distinguish between short and long run effects of financial factors. In particular, the first order conditions from the dynamic optimisation model in Annex 1 suggest that the "going" mortgage interest rate will affect both the short and long run housing plans. The premium function on the other hand and the credit constraints, play a predominant role in the short term adjustment path but less so in the longer term housing plans (the "flow" issue mentioned above). Indeed, under certain circumstances, the optimality conditions suggest that the premium function and the credit constraints will not affect the long run housing plan at all.

The intuition behind this result is straightforward. Consider, for example, what would happen if, other things being equal, a household were given access to a higher debt-asset ratio at the same interest rate. If the household were planning to accumulate housing assets and did not have sufficient own funds, the access to more debt could induce it to anticipate some of its housing purchases. A younger household for example would be less constrained by its current income and could acquire its own house sooner; an older household could "move up" the housing ladder faster. While the short run housing demand is thus affected, the long run housing plan of each household is likely to be little changed by the easier access to debt. In planning for the longer run the household needs to keep an eye on its expected "permanent" income and borrow accordingly. Flow constraints and rising marginal costs of debt are important for the ability of households to "smooth" short run income variations, but less so when it comes to planning their longer run portfolio.

This does not mean that credit conditions other than the mortgage interest rates play no role in long term dynamics of housing demand. For instance, in the above example, even though the long run housing plans of individual households do not change when credit constraints are relaxed, it is still true that younger people will move out of the family and acquire larger houses earlier in their life cycle. Thus, on the aggregate, a relaxation of credit constraints may lead to permanently higher demand for housing services. The main point to draw from the above is that the non-interest rate financial conditions should primarily (but not exclusively) affect the *dynamics* (timing) of housing demand.

Interestingly for our purposes, the above discussion has also some potential implications on how structural changes in the mortgage market may affect housing demand. Though structural changes in the mortgage market cannot easily be identified or measured, there is wide agreement in the literature as to how liberalisation may have affected credit standards and mortgage credit availability. Mortgage market liberalisation is generally thought to have made access to credit easier for a large number of households that were previously effectively excluded from the market. More competition and better credit rating techniques should have led mortgage lending institutions to give less weight on current income and wealth when evaluating the credit worthiness of a household and put more weight on factors signalling high future income. Moreover, with a wider variety of products available in the market and a more persistent marketing of these products by credit institutions, households, particularly young households, are thought to have been better able to find the mortgage products that best fit their income profile. Thus, they should have been less constrained by their current income and wealth and would have had access to larger loan-to-value or debt-to-asset ratios other things being equal. While the possible effects of market liberalisation on quantitative constraints are relatively unambiguous, those on average mortgage costs are a priori more ambiguous. On the one hand, increased competition has probably reduced spreads. On the other, the move from a heavily regulated and sometimes subsidised mortgage system to a freer market may have raised average mortgage interest rates (other things being equal) at least for some households.

In terms of the stylised model in the Annex 1, the premium function $\rho(.)$ would have shifted to the right and down. The "going" (floor) mortgage interest rate, on the other hand, may (or may not) have changed and possibly, other things being equal, it has even increased bringing mortgage rates closer to going market rates. The overall effect of mortgage market liberalisation on *marginal* mortgage costs is difficult to say a priori, but it is widely thought to have been negative (i.e. reduced marginal costs), thus boosting housing demand in the short run. If the arguments above are correct, financial liberalisation should have affected first and above all the short run dynamics of housing demand, but less so the long run relation. This is the issue we return to in the last section of this paper.

3. The Dataset and Model Specification

As is the case with many of the house price studies in Europe, the empirical model is heavily conditioned by data availability. As can be seen from Annex 2, data sources are disperse and data is of varying quality. We use only annual data, both because we believe these to be more reliable and because we thus have a better coverage of EU countries and time.

We use a standard error-correction model (ECM), which permits a relatively straightforward estimation of short and long run effects in a single equation, what is of some interest in the context of the discussion of financial factors, as seen above.[2] In particular, we start from the following general unrestricted ECM specification:

$$(1) \qquad \Delta y_{it} = \mu_i + \sum_{j=1}^{2} \lambda_j \Delta y_{i,t-j} + \sum_{j=0}^{2} \Delta \mathbf{X}_{i,t-j} \boldsymbol{\delta}_j + \alpha y_{i,t-1} + \boldsymbol{\beta}' \mathbf{X}_{i,t-1} + \varepsilon_{it}$$

where $t = 1,2,...,T$ and $i = 1,2,...,N$, μ_i represents the country-specific intercept or fixed effect, $\mathbf{X}_{i,t}$ is a $1 \times k$ vector of variables assumed to cointegrate with y_{it}, α is the error-correction coefficient determining the speed of adjustment to the long-run equilibrium, $\boldsymbol{\beta}$ the vector of (non-normalised) long-run coefficients, and ε_{it} the error term. Direct estimation of equation (1) allows us to obtain also the short-run dynamics, which are given by contemporaneous and lagged changes of $\mathbf{X}_{i,t}$ and lagged changes of y_{it}. The variables included are all those suggested by the theoretical model above and, more or less, standard in the literature. Beside the "real" house prices (*RHP*), our dependent variable, the vector $\mathbf{X}_{i,t}$ includes the real disposable income per capita (*RDIPC*), the real mortgage rate (*RMRATE*), the real stock of mortgage debt per capita (*RMDEBT*) and the total population over 24 years of age (*POP*). The income and debt variables are normalised with the population over 24 years of age, as this is a priori considered to be a better proxy of the number of households. Additionally, we introduce the real stock market index (*RSP*) as one possible (rather imperfect) proxy of financial wealth.

The stylised theoretical model of the previous section referred exclusively to housing demand. Typically, housing supply is considered to be inelastic in the short run. Reduced form housing price equations are therefore basically inverse demand equations with housing capital added in the long run relation to capture the long run supply effects. As a result, we

[2] This empirical approach is standard in the housing literature. Moreover, we opt for a single-equation rather than a two-stage ECM model, because in finite samples, under the presence of cointegration, the bias in the estimates of the cointegrating relationship is larger in static models than in dynamic models (Banerjee, *et al*, 1986).

introduce the residential housing stock (*HSTOCK*), and the “real” construction cost index (*RCOST*) both in the short and in the long run. Even though housing capital may be taken as given in the short run, variations in construction costs can affect short term house price dynamics if they affect expectations of prices of new houses in the future.[3]

Before implementing the ECM model, we test for the order of integration of the single variables used in the estimation. For this purpose, two sets of assumptions can be made for which two standard panel procedures are available. The first test (Levin, Lin and Chu (2002) - LLC) employs the null hypothesis of a common unit root process across cross-sections, implying that the persistence or autoregressive parameter is the same across countries. The second test (Im, Pesaran and Shin (2003) - IPS) allows for individual unit root processes meaning that the autoregressive coefficients vary across-sections and combines the individual unit root tests to derive a panel specific statistic. From the panel unit root tests (Table 1), it can be seen that most variables are found to be integrated of order one in level. The only relevant exception is the LLC test, which indicates that *POP* is stationary in level. All in all, we do not have enough evidence to discard the presence of a unit root in all the variables under investigation, and in what follows we will test the presence of cointegration between these variables in level.

Table 2 displays the results of the panel cointegration tests of Pedroni (1999). These tests are based on a panel unit root test of the residuals from a regression which allows for heterogeneous slope coefficients, fixed effects and individual specific deterministic trends. Pedroni develops seven cointegration statistics under the null of no cointegration. Four of them (“panel” statistics: panel v-statistic, the panel ρ-statistic, and a non-parametric and parametric t-statistic) pool the autoregressive coefficient in the residual based test, whereas three additional three statistics (“group” statistics: group ρ-statistic and two group t-statistics) take the average. One side of the standard normal distribution is used as rejection region. With the exception of the panel v-statistic where the upper-side is used, for all the other tests the lower-side is applied. The main advantage of these tests is that they allow for the presence of heterogeneity of the co-integrating vectors, but the obvious drawback is that in the presence of small T, the country-specific estimates may be subject to substantial biases, above all when a large number of non stationary variables are included.

[3] All variables other than the interest rates are in logs. Annex 2 contains a detailed definition of all variables.

Table 2 shows the cointegration tests for the specifications either with fixed effects or with fixed effects and individual linear trends. With the only exception of the group-*t* test, no test rejects the null of no cointegration in the general specification in columns 1 (*RHP*, *RDIPC*, *RMRATE*, *POP*, *HSTOCK*, *RCOST, RMDEBT* and *RSP*). Columns (2), (3) and (4) test for the presence of cointegration between a subset of the variables included in the general specification. Again, except for the panel and grout *t*-statistics of the standard model accounting for demographic and supply conditions, no test supports the presence of cointegration. Finally, column (5) shows the results for the basic three-variable model in *RHP*, *RDIPC* and *RMRATE*. Four tests reject the null of no cointegration in the specification without individual linear trends. From the above results, evidence of cointegration is stronger for a more parsimonious model, rather than a more general one which includes demographic, housing supply and mortgage debt effects. As will be seen below, these findings tend to be consistent with the results obtained within the ECM approach.

Before discussing the main results, two econometric aspects are worth mentioning from the outset. Firstly, due to the annual frequency of the dataset and the resulting problems of degrees of freedom which may result from the estimation of country-specific models, we will impose homogenous parameters across countries. At the same time, however, we allow for heterogeneity by including fixed effects and, as a robustness check, also individual linear trends. The former captures the impact of all time-invariant determinants of house price growth, whereas the latter accounts for potentially omitted trending determinants of house prices (see below for a discussion). For comparison, we also present the results from a regression where we allow heterogeneity in short term dynamics. The second econometric aspect refers to the choice of estimation method. The use of fixed effects and a lagged term in a ECM specification raises the question whether our estimates are inconsistent as is the case in typical dynamic panel models with a small time dimension. However, the typical Arellano-Bond methodology applied to dynamic panel data models is designed for samples with a large cross-section, which is not the case in our dataset, and, more importantly, our panel is large enough in the time dimension, suggesting that the use of the ordinary fixed effects model is more appropriate in our case.

4. Estimation Results of Benchmark Model

Table 3 below presents the empirical results from ECM models. We start with the standard benchmark model, of the "Jorgenson" type, where the only explicit financial variable is the real mortgage interest rate. The other independent variables are the real disposable income per capita, the population over 24 years of age (as a proxy for the number of households), the housing capital stock per capita and the real construction cost index. The latter two variables capture supply side effects. The disposable income variable may capture in the short run both the change in expected life cycle income and the possible effects of additional internal finance. In a "Jorgenson" type of world, the availability of internal finance should not be of relevance in principle, but changes in disposable income are still likely to have an effect on housing demand via the expectations channel.

In a first general specification (not presented here) we introduced all independent variables in both lagged levels and first differences to capture long and short run effects. We have experimented with contemporaneous and lagged first differences. It turned out that the contemporaneous first difference of income, the lagged first difference of real mortgage rates and the contemporaneous and lagged difference of construction costs sufficiently capture the short term dynamics. Housing stock and population enter only in the long run relation.[4]

Column 1 in Table 3 presents the estimation results from the "trimmed" version of the benchmark model, after having dropped the statistically non significant short term effects. All estimated coefficients have the expected signs and reasonable orders of magnitude. In the *short run*, an increase in real income of 1% is estimated to raise real house prices in the same period by close to 0.6%. An increase of the mortgage interest rate by 100 basis points is estimated to bring down real house prices by close to 0.5% with one year delay. A rise of real construction costs is found to have a positive but short lived effect, which is largely reversed a year later.[5] A significant part of a house price increase/decrease would seem to carry over to the next year. The "persistence" coefficient (of the lagged dependent variable) is estimated to be above 0.5. In the *long run*, the main effects come from the disposable income and population variables. The elasticity of real house prices with respect to income is estimated to 1, that with respect to population to 2.8. The elasticity with respect to housing capital stock is -1.4, although only statistically significant at 10% level. The estimated semi-elasticity with respect to the real mortgage rate is -1.3 and the elasticity with respect to real construction costs is 0.1. Both, however, are not statistically significant. All in all, these findings are

[4] In preliminary estimates we have also added year fixed effects. The inclusion of the latter, however, makes the effect of the real interest rate in the long run insignificant. This could well be a reflection of the fact that real interest rates have had broadly similar long term patterns in most EU countries, though changes have not always been synchronised. The short run effect of interest rates remains statistically significant and quantitatively important. The rest of the results changed little when time dummies were present.

[5] We return to the question of the construction costs below.

qualitatively consistent with a number of recent empirical studies on house price determination (see OECD, 2005 for a survey).

The model in column (1) shows signs of autocorrelation (see bottom of the table). Moreover, the residuals from individual countries show some long term pattern. The residuals from Germany in particular have a clear negative trend. Finally, for some countries, there seems to be much more noise in the data in the first years of the sample, possibly due to more measurement errors in that period. Italy and Belgium present the clearest cases of this. In the following regressions, we consider these issues in more detail.

A priori, we would expect that some of the above problems, particularly those concerning autocorrelation and the long term patterns in the residuals, may be due to omitted variables and/or systematic measurement errors. Even before turning to the financial side, we can think of different potential omitted factors, some of them concerning the supply side, such as construction land availability and cost, innovations in construction technology, changing social habits, urbanisation and regulations etc. Further, systematic measurement errors may arise among other things because of failing to correct prices for changes in house characteristics in terms of quality, size, location or amenities. This type of factors and errors are very hard to measure, but one may reasonably assume that they are likely to have changed more or less monotonically over a number of years, though not necessarily with the same rate across countries. If so, a country specific trend variable could be expected to capture much of their effect. The drawback of course is that by effectively de-trending our data we are removing a lot of variation, potentially making the long run coefficients ill-determined. Like ordinary dummy variables, country-specific trends do not tell us much about the true underlying factors driving the long run relations.[6]

Thus, in column (2) of the table, we re-estimate the model of column (1) introducing also country specific deterministic trends. The trend coefficients are statistically significant ($\chi^2(11)=49$), though it should be said that much of the explanatory power of the trends comes from Germany. In terms of the rest of the estimates, the introduction of country specific trends changes somewhat the short term dynamics and the long run elasticities (which are now *conditional on the trends*). Qualitatively, however, previous results change little. The statistical significance of the coefficients in the long run relation does change, however, and

[6] Hassler (1999) shows that a significant time trend may indicate omission of a variable with a linear trend in mean from the cointegrating regression. In this respect, the inclusion of trends may help to hint at miss-specification.

we can now reject the hypothesis that the long run effect of interest rates is zero. The coefficient of the population term, on the other hand, turns out to be statistically insignificant. Evidently, the trend variables capture some of the effect of the population term. Finally, even with trend variables we reject the null hypothesis of no autocorrelation at the 10% level.

We consider next amending the financial side of the model. Hence, we depart from the standard "Jorgenson" type of model and introduce two extra financial variables, the mortgage debt per capita and the stock market index (both in real terms). Mortgage debt reflects the external financial constraints faced by households and, as discussed above, is expected to be related mainly with the short term house price dynamics. Similarly, stock market prices affect the households' wealth, and thus the availability of internal financing, but could also capture expectations about the future.[7] Mortgage debt not only captures supply side conditions on the mortgage market but also changes in the demand for credit. We use, therefore, the lagged value of mortgage debt growth as instrument.[8]

Columns (3) and (4) of Table 3 present respectively the amended model without and with the trend variables. In both cases, the introduction of the two financial variables improves significantly the explanatory power of the model. Autocorrelation tests also improve.

The estimated coefficients confirm the positive relation of house prices with both mortgage debt and stock prices in the *short run*. Quantitatively, the short run effect of stock market prices on house prices is relatively small. This is not surprising given the presumambly small share of equity in the typical household portfolio in our sample. Instead, the role of mortgage financing is quantitatively important. A 1% rise in mortgage debt is related to roughly 0.5%-0.6% short run increase in house prices, ceteris paribus. The rest of the short run coefficients also change with the introduction of the two financial variables. Most noteworthy is the drop in the coefficient estimates for the lagged dependent variable and of income in the short run. In other words, part of what appeared previously as "persistence" in house price dynamics or as an income effect, is now explained as an effect on house prices from changes in credit availability. The estimated impulse effect of interest rates also falls somewhat below -0.4.

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[7] Stock market prices could also capture the opportunity cost of investing in housing (to the extent that housing is treated as a normal portfolio decision by households). In this latter case, there could be a negative relation between changes in real house prices and in real stock prices.

[8] We also experimented with a number of additional instruments like the lagged change in long run interest rate, the lagged real disposable income growth and the lagged change in private debt per capita though, in practice, these made relatively little difference to the results. Note also that we lose 34 observations due to the unavailability of mortgage debt data. Re-estimating the model in columns (1) and (2) with the smaller data set leaves most of the results unchanged.

In the *long run*, stock market prices turn out not to be statistically significant, while mortgage debt is estimated to have a relatively moderate but persistently positive effect on real house prices (long run elasticity of about 0.2-0.3). When dropping mortgage debt from the long run relation, the long run semi elasticity of house prices with respect to interest rates rises by about 0.5 in both models (while that of income and the other variables remains largely unchanged). Mortgage interest rates and mortgage debt would seem to capture in part the same long run effect of "financial conditions" on house prices.

The long run elasticity with respect to income rises in this model close to 1.5. In contrast, the long run effect of population, capital stock and construction costs turn out to be statistically insignificant in both models. This does not necessarily mean that all of these factors have not played a role for long run house price developments. Capital stock and, to certain extent, population have little variation year by year and this makes it difficult to get reliable estimates of their long run effect. Despite this, in some of the specifications population dynamics seem to play a role for long term house price developments. On the other hand, the statistical insignificance of construction costs and capital stock may also indicate that the main supply side factor may have been land availability (and cost), rather than the availability and construction cost of the buildings.[9] Whatever the case may be, we find that we can drop the population and supply side variables from the long run relation with little effect on the rest of the estimation coefficients and this is what we do in the rest of the empirical investigation.

Summarising so far, we can say that there is a strong case for amending the standard ("Jorgenson type") house price model by introducing mortgage debt (and stock prices). Short term house price dynamics, in particular, seem to have been driven by financial factors (interest rates, mortgage debt, stock market prices), as well as by variations in income and construction costs. Point estimates vary somewhat from specification to specification, but qualitatively the results are robust to changes in the model. In the long run, we find that income has been the main driving factor. The long run elasticity of house prices with respect to income is estimated between 1 and 1.5. The estimated semi-elasticity of house prices with respect to interest rates is relatively low, somewhere between -1 and -2, with respect to mortgage debt is around 0.3. Country-specific deterministic trends could be capturing omitted

[9] Having said that, it is possible that construction bottlenecks could have caused temporary increases of costs and prices, as the short run construction cost coefficient suggests. The (rather poor) information available on land prices suggests that these have tended to increased much faster over the long run both compared to house prices and, even more so, compared to construction costs (see ECB, 2003).

variables in the long run relation, possibly related to supply and demographics. The "preferred", more concise model (without and with trends) is presented in the first two columns of Table 4. The same comments apply as above. The rest of Table 4 shows some variations of the "preferred" model. In column 3, we re-estimate the model (with the trends) lagging the mortgage debt instruments by two periods to ensure that we are not capturing any feedback from house prices to mortgage debt. The estimate of the impulse effect of debt is always statistically significant and quantitatively important, albeit somewhat lower (compared to that in column (2)). All the remaining short and long dynamics are similar, though the "persistence" coefficient (of the lagged dependent variable) rises again to 0.5. This interaction between the short term house price dynamics attributable to changes in the mortgage debt and the "persistence" in house price inflation is of some interest as will be seen in the next section.

In column 4 we estimate the model allowing for heterogeneous dynamics in the different countries. In particular, the short run terms are country specific, while we pool the long term coefficients. The main difference in these estimates compared to our preferred model in column (2) concerns the effect of the mortgage interest rate. The new coefficient estimates suggest that, in the short run, the negative effect of mortgage interest rates may be smaller, but the long run elasticity is actually higher. Other than that, the point estimates, particular in the long run, remain relatively stable, though the coefficient associated with the real mortgage debt turns out to be statistically insignificant in the long run. The average across countries of the individual short term factors are also similar to the pooled models. This model, however, seems to suffer serious problems of autocorrelation.[10]

A further point should be briefly mentioned here. With the introduction of the debt and stock market variables, the coefficients of time trends become negative for all countries and in all variations of the basic model with few country-specific exceptions. In other words, once we take into account the changes in debt and stock market prices, it appears as if real house prices have risen *less* than what would have been expected. One possible interpretation of this is that the combined long term effect of housing supply and demographics (two variables meant to be captured by the country-specific trends) has been to depress house price growth.

[10] In preliminary analysis, we re-estimate the model (with trends) using FGLS, taking account of period-specific heteroscedasticity. As mentioned earlier, noise in data appears to be much higher in early periods, possibly because of measurement errors. With FGLS point estimates change somewhat, but results remain on the whole very much the same. Standard errors decrease for all coefficients.

While this is an interesting hypothesis, testing it goes beyond the scope of this paper and we leave it for future research (and better supply data).

5. Possible Effects of Financial Liberation

So far, we have followed much of the existing empirical literature and assumed that the house price relation has remained stable over time. One of the most obvious reasons why this may not have been the case is the liberalisation of the financial system. The literature has extensively documented a number of structural changes in the financial system in general and in the mortgage markets in particular, over our observation period. Though changes have varied in form and in timing, there has been something of a common pattern in most EU countries. This broadly involved a move away from interest rate caps and quantitative constraints in the late seventies and eighties, a relaxation of the rules on the specialisation of credit institutions and a gradual deregulation of the mortgage markets mostly in the eighties and early nineties and, more recently, measures aimed at promoting consumer protection and mortgage debt securitisation. In some countries, there has also been a parallel move towards bank privatisation and a related market restructuring as well as a reduction of state activities/direct subsidies in promoting owner occupation, though often a strong bias towards owner occupation and mortgage credit remained (or was even strengthened) in the tax system (IMF (2000) and ECB (2003)).

Unfortunately, it is very difficult to time more precisely these changes or to find one or more indicators that could measure mortgage market "liberalisation" in different countries over a longer period of time. Most of the indicators we could think of either concerned one specific aspect of the market – indeed often they were market outcomes - that may or may not have been the result of "liberalisation" (e.g. loan-to-value ratios) or were unreliably measured over a longer period of time (e.g. mortgage market concentration or penetration) or both. A first attempt to estimate the direct short run effect of liberalisation measures using dummy variables has given poor results. In particular, making use of the information on mortgage market deregulation reported in ECB (2003) and in Lacat and Mesonnier (2005), we identified the dates of the main financial liberalisation measures in each country (see Annex 2) and based on that we constructed a dummy which takes the value of 1 in the year such measures were implemented, and 0 otherwise. A second dummy was assigned a value of 1 after the major measure was applied, and 0 otherwise. The idea was that, even if we had missed some measures, we would have captured enough points in time to have an idea of the permanent or temporary effects of liberalisation measures. We introduced the two dummies in the preferred model of columns 1 and 2 of Table 4. As it turned out, both have a quantitatively small impact and are statistically insignificant. Varying somewhat the time frame (e.g. introducing dummies with a lag compared to a liberalisation measure and/or allowing each dummy to cover more than one year) did not provide any more interesting results. In all of the regressions, the rest of the estimated coefficients were unaffected by the introduction of these dummies.

Clearly, one of the biggest problems with such an exercise is that of the correct dating of "liberalisation measures", assuming a single date does indeed exists. More likely, regulatory and other changes in the mortgage market have taken longer periods to complete and had gradual effects on market practices. Moreover, in view of what was said earlier, there is no reason to believe that such changes can be captured by a shift in the intercept of the house price model, with no effects on the rest of the relation between financial variables and house prices. As argued earlier, financial liberalisation would have changed the *marginal* cost of finance and should have primarily affected short term dynamics of the house price relation.

Though it is not a formal test of this hypothesis, we may look at different sub-periods of our sample and check whether estimated changes in coefficients are consistent with what the literature on mortgage markets would suggest should have happened. Clearly, we can not exclude that any changes in short term dynamics and/or long term elasticities of the house price equation could have been the product of other structural changes, more or less common to all European countries. In Table 5, we rerun the "preferred" model (of column 1 and 2, Table 4) allowing the coefficients of all independent variables to change from 1990 onwards. The year 1990 is arbitrarily chosen as a possible "break point" because it divides our sample roughly half way. A priori, 1990 is not a bad choice since many countries completed important steps of their financial liberalisation programmes around that time.

Columns 1 of Table 5 present the model without trends, with the estimated coefficients for the period before and after 1990. Columns 2 are respectively the pre-1990 and post-1990 estimated coefficients from the model with trends. Clearly, these models are over-parameterised, containing as they do, apart from trends, 11 fixed effects and 2x10 independent variables. Point estimates should therefore be considered with caution, though the direction of change of these coefficients before and after 1990 is potentially of interest.

The estimates suggest that *short term* house price dynamics have changed. Though there are some differences in the estimated parameters of the two models, with and without trends, the essential message is the same: The most important changes observed in the estimated parameters after 1990 are the drop of the income impulse effect (from about 0.5 to about 0.1) and that of debt (from 0.7 to about 0.1) and the corresponding increase of the short run effect of an interest rate change (from about -0.4 to about -0.6) and the coefficient of lagged dependent variable from below 0.4 to about 0.6).[11]

One way of describing the changes observed in the short term dynamics is that pricing of housing assets has become more akin to that of financial assets, i.e. their demand being more influenced by interest rates and past capital gains (feeding through expectations) and less so by household income and quantitative financial constraints. The apparent "de-linking" of house prices from income developments has been an issue of some speculation recently, when house prices continued to grow strongly in a number of EU countries even during the downturn in economic activity of the last few years of our sample. This was generally attributed to the changes in the financial system that should have made it easier for households to access external finance for a given (current) income and given availability of own-capital.[12] Similarly, the higher impulse effect of interest rates on house prices is along the lines of the argument put forward by Iacoviello and Minetti (2003) on the possible effects of financial liberalisation on the impact of interest rate shocks on house prices. To our knowledge, the reduction of the impulse effect of quantitative credit variables on house prices has not been noted in the literature, though one could rationalise this as a sign of credit constraints becoming less binding. We return to the coefficient of the lagged dependent variable below.

While these changes in the short term dynamics of house prices are the main focus here, it is interesting to note that the empirical *long run* relation between house prices, income, interest rates and mortgage debt turns out to be relatively more stable between the two sub-periods of

[11] Though point estimates vary, the direction of changes in the estimated coefficients remains true when we move the "break year" or change methodology (e.g. drop the instruments).

[12] This argument is not uncontroversial. For instance Almeida *et al* (2006) and Lamont and Stein (1999) find that the sensitivity of housing prices to household income changes is positively related to a relaxation of financial constraints. Following the former, we also interact the change in per capita real disposable income with the maximum loan-to-value (LTV) ratios which they use as proxy for financial liberalization. Results (not shown here but available upon request) show that the interaction term is statistically insignificant. This may be due to the different country sample which in our case is much more homogeneous but also to the quality of their financial constraint index.

our sample.[13] In particular, the estimated long run elasticity of prices with respect to income and with respect to debt remained stable. There is no indication of a long run "de-linking" of house prices and income. The semi-elasticity with respect to interest rates would seem to have changed somewhat, but given that this coefficient is not very accurately estimated, we cannot reject that also this has remained constant between the two sub periods.

In Table 6 we reproduce the above results, this time using different "break points" for the various countries. In particular, we now split the sample for each country according to the "dates of financial liberalization" measures mentioned above (see Annex 2). This approach has the advantage of allowing for a "possible" country-specific break point, but at the same time it reduces the number of observations of the pre-liberalization period by 39 observations.[14] Most of the results outlined in Table 5 seem robust to this alternative splitting procedure. The only noticeable difference is that the impulse effect of mortgage debt remains in these models high also in the post-liberalisation period. Also, the short run effect of stock prices is now consistently more relevant in the latter period.

In line with what was discussed in the first part of this paper, our tentative interpretation is that changes in financial structures had an impact primarily on short term dynamics, reducing, ceteris paribus, the marginal cost of mortgage debt. The short run elasticity of house prices with respect to interest rates increased as a result. While changes in financial structures led households to anticipate house purchases, their longer run plans were not too much influenced. Being able to borrow more and to borrow earlier in the life cycle can raise the speed with which households realise their housing plans. For example it can reduce the average age of first-time buyers, but in the longer run housing plans should not change much. Income growth remains the main factor affecting these plans in the long run.

So far, we have considered the possible changes in the estimated coefficients pre- and post-liberalisation using different break points (1990 or country specific) and different models (with or without trend variables). The natural question that follows is whether we should not

[13] A Wald test does not reject the hypothesis of constant long run coefficients ($\chi^2(4)$=3.3, $\chi^2(4)$=1.5 in the two models respectively). This observation needs some qualification however. When the model is run separately for the sub periods, as is done below, we can observe some changes in the long run elasticities. In particular, it seems that at least in some specifications the long run elasticity with respect to income rises in more recent times, though it is more difficult then to directly compare point estimates from different models. Concerning the short run relation, we can reject the hypothesis of constant coefficients at 10% level in the model without trends ($\chi^2(6)$=10.5), but not in the model with trends ($\chi^2(6)$=7.9), presumably because of the over-parametrisation of the latter.

[14] According ECB (2003) and Lacat and Mesonnier (2005), Germany had already introduced the major mortgage reforms in the 1960s. Therefore, the reduction of observations is mostly due to the exclusion of Germany from the pre-liberalization period.

allow also the error structure to vary from one sub-period to another, given that, as mentioned earlier, measurement and other errors may have also changed over the 35 years we are considering. Thus, in Table 7 we re-estimate the model separately for the two sub-periods, using both the common break point of 1990 (columns 1 and 2), and the country-specific break point based on the financial liberalization dummy (columns 3 and 4). Given the short time frame of each sub-period (and the reduced degrees of freedom), we comment only on the regressions without time trends. It should be said, however, that the absence of time trends makes adjustment to the long run appear much slower. Additionally, given the stability of the long run coefficients, for both sub-sample we include the same error correction term (ECT), which apart from house prices, includes income, mortgage interest rates and mortgage debt. We fix the respective elasticities at 1.1, -2.3 and 0.3, which are the long run coefficients estimated imposing the same cointegrating relationship for the two sub-periods. The correspondent long run elasticities for the models with country-specific break points are 1, -1.6 and 0.2. Concerning the short term dynamics, we keep the same specification as in Table 7 and Table 6.[15]

These regressions do not impose the same error structure and the same country fixed effects in the two sub periods, unlike the models in Table 5 and Table 6. Nevertheless, the qualitative results are very similar to those of Tables 5 and 6. One can see again that the factors entering the house price short term dynamics seem have changed over time, with financial "price" variables (interest rate and to lesser extent share prices) being more important in recent years than was the case before 1990. Instead, the impulse effect of income and debt turn out to be statistically non significant (and quantitatively smaller) in the more recent period.

Figure 1 provides an illustration of how short run house price dynamics may have changed over time. The charts show the estimated coefficients of the short term dynamics estimated with rolling regressions using a 15-year window. The specification is the same as that used in Table 7 (columns (1) and (2) for the ECM). Although the wide confidence bands point to high degree of uncertainty around the point estimates, the rolling coefficients are consistent with a gradual transition from the pre- to the post-liberalization period. The clearest changes seem to be the drop of the impulse effect of mortgage debt and an increase in the "persistence" factor (the coefficient of the lagged dependent variable). There seems to be also

[15] We have also tested for richer short term variables, including DRMRATE, DRDIPC(-1), DRCOST(-1), but they all turn out to be statistically insignificant. The shorter time periods and the fewer degrees of freedom do not allow for that much further experimentation.

a gradual change in the impulse effect of income, mortgage interest rates and share prices along the lines mentioned earlier.

Finally, the increase of the estimated coefficient of the lagged dependent variable in the post-liberalisation period warrants some further comments. We interpret this as a sign that in a world where households can enter/exit the mortgage and housing markets more easily and manage their portfolios, including their housing assets, more actively, house buying/selling decisions may more often be made with an eye to capital gains, than was the case in the past. If there are extrapolative elements in households' expectations, recent house price movements may feed more strongly into current housing demand decisions. This interpretation is not the only one, but seems a plausible one and finds some support in the literature. Muellbauer and Murphy (1997) argued, in particular, that such behaviour could give rise to "frenzies" if there is a large number of speculative traders in the market. Following an earlier suggestion of Hendry (1984), they introduced a cubic function of the lagged house price increases to capture possible non-linearities due to such "frenzy" effects and found this to add to the explanatory power of their model.

Following a similar approach, we find no evidence of "frenzies" in the sense used by Muellbauer and Murphy, but we do find evidence of a more complex dynamic adjustment in house prices in recent years (results are available from the authors). In particular, when entering the second lag of the dependent variable in both linear and cubic form, they both turn out statistically significant in the more recent period but with opposite signs (the coefficient of the cubic term is negative). Taking the point estimates literally, the model suggests that, for low house price increases/decreases, the effect of the cubic term roughly cancels out with the second lag of the dependent variable. For growth rates exceeding 15% (or below -15%), the overall effect becomes increasingly negative (positive). In other words, while house price increases tend to be followed (ceteris paribus) by further increases in the two next years, extreme movements of house prices in one year tend to be followed by a deceleration effect two years later. This could be a sign of a more complex household expectation mechanism (which interprets extreme movements as "bubbles") but it could also be for instance the result of supply catching up with demand shocks. The question of whether changes in the housing and mortgage markets have actually altered the way households make decisions about housing and form their expectations of house prices is an interesting one and probably warrants more research.

6. Conclusions

The relation between financial factors and house price dynamics has been in the limelight in recent years. As suggested by the discussion in the first section of this paper, the observed interest rate channel is probably one part of this relation. Factors affecting the marginal effective cost of mortgage debt, often not fully captured by the "posted" interest rates, can have a significant influence on housing demand, particularly for what concerns short term dynamics. In the absence of a better measure of these factors, we have used (mortgage) debt as a proxy, in line with much of the rest of the literature.

Relying on a standard one-equation reduced form model, expanded to include supply side variables and deterministic country-specific time trends, we find that, alongside with income and construction costs, (lagged) interest rates, mortgage debt and, to lesser degree, stock market developments have had a significant impact on short term house price dynamics in our sample of EU countries since the early 1970s. In the long run, the elasticity of (real) house prices with respect to (real) income is found to lie between 0.9 and 1.5, the semi-elasticity with respect to interest rates between -1.2 and –2.6. Mortgage debt seems also to enter in the long run relation, albeit with a relatively low elasticity (around 0.3).

When we split our sample to check for possible effects of financial liberalisation, we find that the relation between financial factors and house price dynamics is much more complex and less stable than what the initial models would seem to suggest (I suggest rephrasing this sentence given that the changes are often insignificant). The changes between the two sub-periods concern mainly short term dynamics and in general they are consistent with what one would expect the likely effect of financial liberalisation have been on house price dynamics. In particular, the impulse effect on house prices of income and mortgage debt has become smaller, while that of interest rates, past increases of house prices and, to lesser degree, stock market has strengthened. We could not find a clear cut pattern as far as the construction costs were concerned. In other words, there seems to have been a certain "de-linking" of short term house price dynamics from "real" income accompanied with a certain change whereby the housing market may have become more similar to a financial market, with interest rates and expectations of capital gains playing a more prominent role. From a policy point of view, it is also interesting to note that we find little evidence of important changes over time in the long run relation. In particular, the long run elasticity of house prices with respect to income, interest rates and debt would not seem to have changed significantly over the two sub-periods we consider.

In conclusion, we think the question of whether changes in financial structures have affected house price dynamics and, in particular, whether the more favourable credit conditions have affected primarily the short term house price dynamics warrant further investigation. This paper puts an argument why this may be the case and provides some tentative results that support this hypothesis. Future research will probably need more reliable information on how credit standards may have changed over time as a result of structural changes in the mortgage markets and how these affected house price dynamics.

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Annex 1: Theoretical model

To illustrate the point made in the text concerning short and long run effects of financial factors on housing demand, consider the following stylised dynamic optimisation model:

$$(1) \qquad \max \int_{0}^{+\infty} e^{-rt} u(c+f)dt$$

The household plans housing investment and debt at time t=0 so as to maximise (1). This plan may be changed ("re-optimised") as time progresses and new information becomes available.[16] In (1), u is the household's utility function (u'>0, u''<0), c is the (real) consumption of goods and services (other than housing services) and f is the consumption of housing services from a housing stock H ($f'(H)$>0, $f''(H)\leq 0$). Finally, r is the opportunity cost (the going market interest rate).[17]

Next, we write the income identity of the household as follows:

$$(2) \qquad c = y - mD - qI + \dot{D}$$

In words, consumption each period is equal to current (non-interest) income, y, minus interest paid on (net) debt and minus the "own capital" investment in housing. Net interest paid is expressed as mD, where D is the net debt outstanding (when negative these are the net outstanding financial assets) and m is the effective average interest rate paid (received) by the household. The gross investment in housing is qI (q is the current price of a unit of housing stock in terms of consumption goods) and $\dot{D}$ is the change in net debt. Finally, housing assets change according to the following equation of motion, where δ is the physical depreciation of housing capital.

$$(3) \qquad \dot{H} = I - \delta H$$

So far the model is relatively standard. We next introduce an upward slopping credit supply function, as mentioned in the main text. In particular, if d is the ratio of net debt over housing assets (D/qH), the cost of a unit of debt that the household has to pay is written as follows:

[16] This is the simplest (and possibly most realistic) optimisation strategy, where households do not try to make upfront an optimal plan for every possible eventuality ("state of the world"), but use instead their best prediction of future events to come up with a single plan, *as if* future events were certain.

[17] Current consumption and consumption of housing services are unrealistically assumed to be perfect substitutes in (1), but this is of little relevance in the context of the discussion here.). For a special case of a utility function along the lines of (1), see Iacovello and Minetti (2003). A more realistic model of the consumption-housing decision would require a utility function with more than one arguments and considerably more notation. See, for example, Ayuso and Restoy (2006).

(4) $m = r + \rho(d - \bar{d},.)$ for $d > \bar{d}$

and $m = r$ for $d \leq \bar{d}$

where $\rho(0) = 0,\ \rho' \geq 0,\ \rho'' \geq 0$

In words, the unit cost of net debt is the going market interest rate, *r,* so long as the debt-asset ratio is below some threshold, $\bar{d}$.[18] Beyond this threshold, the household pays an individual risk premium, ρ, which may include both higher interest payments and non-interest rate costs of debt.[19] The premium is an upward slopping function of the debt-asset ratio. It could be influenced also by other factors, such as income or various household characteristics. One may introduce also an upper credit constraint, somewhere around *d*=1, but for simplicity we will assume below that mortgage costs rise fast enough at the margin never to be optimal to hold too much debt.

Thus, the path of housing capital and debt are chosen so as (1) is maximised subject to (2), (3) and (4) and excluding explosive paths (infinite bubbles). This dynamic optimisation model is somewhat more complex than usual because it involves two control variables (housing investment and net new debt) and the corresponding two state variables. A detailed description of optimisation models of this type can be found in the literature, an early example is Steigum (1983). We do not expand on the formal details (available from the authors), but concentrate on the couple of points made in the main text.

Substituting the marginal utility out of the Euler equations (not shown here), we may derive the following condition that holds throughout the planned optimal path of housing investment and debt:

(5) $f' = q(\delta + m + m'd(1-d)) - \dot{q}$

In words, along the planned optimal path, the marginal return to housing capital (lhs of (5) is equal to what we may call the *marginal* user cost of capital (rhs of (5)). The latter includes the usual depreciation and capital gains terms but differs from the common user cost of capital formulas in that it includes the *marginal* financial cost of debt. In particular, the last

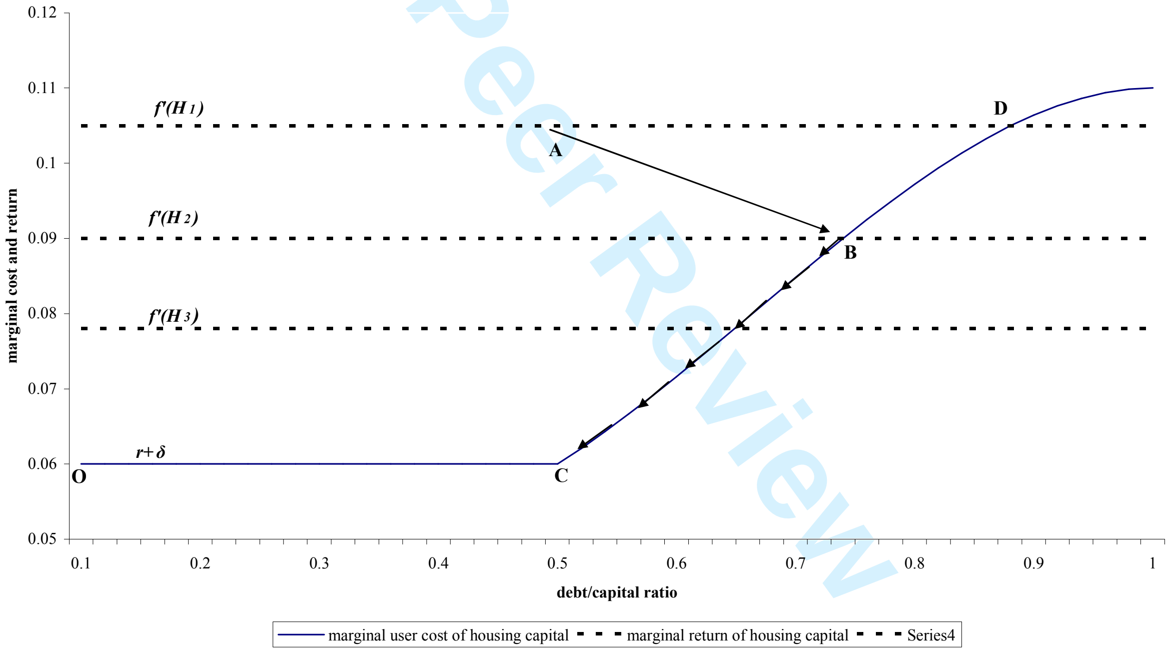
[18] One can easily extend this model to include the possibility that the basic mortgage rate is not equal to the opportunity cost of the household (the discount factor in (1)), for example because of tax deductibility of mortgage interest payments. For simplicity, we do not consider this case here (but see comment below).

[19] To avoid issues of discontinuity at $d = \bar{d}$, one also needs to assume that $\rho'_{+}(0,\cdot) = 0$

term in the parenthesis captures the marginal cost when the interest premium changes because of the debt/capital ratio changing.

Chart 1 below, provides an illustration of the optimal plan of household indebtedness. For simplicity, the individual risk premium function $\rho(.)$ is taken to be quadratic and the relative price of capital, q, is normalised to 1 (thus there are no capital gains to be made).[20] The horizontal axis shows the debt-asset ratio of the household, the vertical shows the marginal return and the marginal user cost of housing capital. The marginal return is represented by the horizontal line $f'(H)$ which shifts down as capital increases if there are diminishing marginal returns to housing capital. The kinked line OCB represents the marginal user cost of capital that rises after the debt-asset ratio exceeds a threshold, set here to be 0.5.

Chart: Optimal financial plan of the household



Suppose the household starts with a relatively low debt-asset ratio (below 0.5) and few housing assets (H_1). The marginal user cost of capital is, at point C, much lower than the marginal return at $f'(H_1)$ (point A). Thus, the optimal plan will entail an initial large increase in debt and corresponding increase in housing capital, say from H_1 to H_2. The new short run optimum will be at point B where marginal return and marginal cost meet. Thereafter, and along the entire optimal plan, the household will use some of its savings to make incremental

[20] As an illustration, we set the (real) going market rate to 2% and the housing depreciation to 4%. The coefficient of the quadratic risk function is set to 0.2.

housing investments while at the same time *reducing* its debt-asset ratio. Both the marginal return of housing assets and the marginal cost of debt will be falling along this path. This optimal plan is depicted in the chart by the movement from B towards C. Throughout this path, the optimality condition (5) holds (i.e. the dotted line shifts down as H increases tracing the BC line). According to this optimal plan, in the longer run, the household will bring down its debt level to a "safety" region where it will not have to pay an additional risk premium. In the above Chart, in the long run, $f'(H)$, reaches the OC line. The optimal debt-equity ratio is anywhere between O and C, i.e. between 0 and 50% in our example and the risk premium paid on debt by the household over and above the going market rate is zero. and the optimality condition (5) simplifies to the following (long run) condition, familiar from the "Jorgenson" type of models:

(6) $$f'(H_e) = q(\delta + r) - \dot{q}$$

where H_e is the planned long run optimum capital.

Note that this is not the only possible path a household may choose. If, for example, there are no diminishing returns to housing capital, the household will have an incentive to continue to direct all its savings to housing investment, instead of repaying its debt. The $f'(H)$ line does not fall in this case as H increases and the optimal plan is for a debt-asset ratio corresponding at point B of that Chart both in the short and in the long run. The household will plan to continue paying an "individual" risk premium throughout the planning horizon. Other variations of the model, for example allowing the minimum lending rate (paid by the more creditworthy households) to be below their opportunity cost (e.g. because of tax deductibility of mortgage interest payments) can give intermediate results, i.e. the planned long run debt-asset ratio could be somewhere between C and D.

There are three points this stylised model helps to illustrate.

First, conceptually one may distinguish between two components in household financial costs. One component is dependent on the current financial situation of the household (the "individual risk premium") and one is linked to market conditions irrespectively of the "identity" of the household (the "going" interest rate). Even though in practice it is not always easy to say the one from the other in the more complex multi-year mortgage contracts, the important issue identified in the model above is that the individual risk premium is likely to be rising with household indebtedness at least beyond some threshold. This will give rise to an upward slopping credit supply curve for the individual household. Credit constraints may be thought of as a special case where the supply curve becomes perfectly inelastic.

Second, because the individual risk premium is rising at the margin, it will affect the ability of households to smooth wealth over time and, thus, also it will affect the speed with which the household can accumulate housing capital. In the above chart, for example, for a given market interest rate, a more elastic supply of credit (less steeply sloped CB line) would have meant that the household would find it advantageous to initially take out more debt and accumulate more housing capital (the point B would be more to the "south-east"). In other words, the fact that credit institutions use the current indebtedness of households to allocate and price loans means that households generally have an incentive (or face a constraint) to take out only as much debt as their wealth will allow if they wish not to pay too high premia. This limits also their ability to spend on housing at any moment in time. If the credit criteria change (e.g. credit conditions are relaxed), households may have an incentive to anticipate or postpone their planned housing investment, even if the market interest rate and their income has not changed.

Third, the model suggests that while a change in credit conditions is likely to have a significant impact on the timing of investment and debt, as mentioned above, the longer run plan of a household may or may not be affected by the shape of the credit supply function. In the example given above, the household faces in the long run a perfectly elastic supply of credit (the OC line). As a result, the planned long run optimum capital H_e in (6) does not depend at all on the shape of the individual risk premium function ($\rho(.)$), though it depends on the market interest rate.

The rationale for this last result is that, over the longer run, the household will be able to accumulate own capital and thus improve its financial standing, bringing down the individual risk premium that it has to pay. As mentioned above, whether the household will indeed plan to bring down its indebtedness depends also on the marginal return of housing and other assets. Nevertheless the example illustrates the point that, over the longer run, households may plan to accumulate own wealth which can ease the financial constraints they face in the short run and be faced with a more elastic credit supply. A change in financial constraints or on the individual risk premium charged by credit institutions is likely therefore to have a dying out effect on the demand of housing assets of individual households. Financial flow constraints and/or individual risk premia of the type described above act as costs of adjustment from one level of housing demand to another.

Annex 2: Data

Data was collected from various international and national sources. Typically, one or two main sources covering more than one country were used for each variable, filling gaps, particularly in earlier periods, from national sources. Only when not possible to find the required missing data from national sources, did we resort to linking series after checking the overlapping periods. One may find more information on these sources and data limitations in ECB (2003), where a large part of the same data set was used. We list below the main sources variable by variable and, in the case of house prices, country by country.

The following country abbreviations are used: BE for Belgium, DK for Denmark, DE for unified Germany, WG for previous West Germany, IE for Ireland, ES for Spain, FR for France, IT for Italy NL for Netherlands, FI for Finland, SE for Sweden and UK for United Kingdom.

The following abbreviations of sources are used: *Ameco*: European Commission Ameco database; *BIS*: Bank of International Settlements, *ECB/ESCB*: European Central Bank and European System of Central Banks (including individual National Central Bank data); *ESA95*: European System of Accounts 95; *HS*: National Agency for Entreprise and Housing, Denmark (see references); *IFS:* IMF International Financial Statistics; *NSI*: National Statistical Institute; *MEI:* OECD Main economic indicators; *OEO*: OECD Economic Outlook

Nominal House Prices (HP)

BE: *BIS* (based on real estate sector data)

DK: *NSI*

WG (DE): *ECB/ESCB* (based on real estate sector data) refers only to regions in ex-West Germany

IE: *BIS, ECB/ESCB* (based on data from the Department of Environment and Local Government)

ES: Ministry of Housing – prior to 1988 refers only to Madrid

FR: *ECB/ESCB*, National Sources (FNAIM and ECLN)

IT: *ECB/ESCB* (based on real estate sector data) - main cities.

NL: *ECB/ESCB*, Land Registry Office

FI: *NSI*

SE: *NSI*

UK: Real estate sector data

RHP is constructed deflating the nominal house price with the consumer price deflator (see below)

Consumer price deflator

Sources: Eurostat, ECB/ESCB, BIS. For Euro-area countries, we used HICP data, linked backwards to CPI, excluding the owner-occupied component. For DK, SE and UK we used CPI data. An alternative deflator based on the GDP deflator was also tried and led to practically the same results.

Nominal disposable income

Sources: *OEO*, *Ameco* and national sources. For Germany, data from regions in ex-West Germany was used. The real disposable income per capita (*RDIPC*) is constructed using the consumer price deflator and the total population aver 24 years of age.

Nominal mortgage interest rates

Sources: *ECB/ESCB*, *BIS* and national sources. For some countries, mortgage interest rates are not available for the 1970s. We have therefore linked the existing mortgage interest rate series with series on long term interest rates. The real mortgage interest rate (*RMRATE*) is constructed as the difference between the nominal mortgage rate and the *ex-post* inflation rate based on the consumer price deflator.

Long term interest rates

Sources: *ESCB/IO, OEO, MEI, BIS*. The basic definition refers to 10 year government bonds or the closest series we could find. For Spain from 1977 backwards we linked with the deposit short term interest rate. The real long term interest rate (*RLRATE*) is constructed as the difference between the nominal long term interest rate and the *ex-post* inflation rate based on the consumer price deflator.

Mortgage debt

Sources: ECB/ESCB, BIS, national sources. We use as main definition the end of period outstanding loans to households for house purposes. For missing data, we use the BIS "credits for domestic residential construction" data and also national source data with the closest possible definition. The real stock of mortgage debt per capita (*RMDEBT*) is constructed using the consumer price deflator and the total population aver 24 years of age.

Population statistics

Source: *Eurostat.* Data for Germany refers to the regions of ex-West Germany. *POP* is the total population above 24 years of age.

Housing Stock

The residential housing stock (HSTOCK) is calculated with the perpetual inventory method using residential investment data from *ESA 95* and *OEO*. Information on number of dwellings per country (Housing Statistics of the European Union, 2002) was used in order to calculate the "benchmark" (or initial) capital for each country. This was done comparing the change in the actual number of dwelling over a certain period and the residential investment over the same period (details available from the authors). We imposed 2% annual depreciation, but checked that small variations to this rate made no difference to the results**.** For Germany, we used data from ex-West Germany.

Construction costs

Various national sources, *ESA 95, OEO*. Where not available, the residential investment deflators were used instead (linked when necessary to the rest of the construction cost data). The alternative, of using throughout the residential investment deflators was tried and produced practically the same results. Real construction costs (*RCOST*) is calculated using consumer price deflator.

Stock exchange price index

BIS, IFS. The real stock price index *(RSP)* is constructed using the consumer price deflator.

*Dates of Mortgage market measures according to ECB (2003) and Lacat and Messonier (2005)***.**

Belgium (1977, 1995), Denmark (1982), Finland (1986, 1987), France (1987), Germany (1967), Ireland (1985), Italy (1983, 1988), Netherlands (1980, 1992), Spain (1987), Sweden (1985) and the U.K. (1980, 1986).

The 'financial liberalization' period of Tables 8 and 9 is based on the date of the latest mortgage market measure.

Table 1 Panel Unit Root Tests

	RHP	*RDIPC*	*RMRATE*	*HSTOCK*	*POP*	*RSP*	*RMDEBT*	*RCOST*
Level								
No trends								
LLC	2.38	-1.47	0.69	3.26	-6.05**	1.18	2.68	-1.24
IPS	1.24	1.44	0.03	-1.41	0.10	1.25	5.87	-0.42
With trends								
LLC	2.56	-0.93	2.17	-1.32	2.28	-0.88	-1.30	-0.96
IPS	-1.18	-0.96	3.46	1.56	4.17	-1.23	-0.57	-0.50
First difference								
LLC	-4.84**	-7.19**	-10.72**	-2.35**	-0.92	-8.49**	-0.87	-7.10**
IPS	-5.32**	-7.53**	-12.20**	-0.91	-1.77**	-9.12**	-2.97**	-7.81**

Notes: *LLC* stands for the Levin, Lin and Chu tests in which it is assumed that there is a common unit root process. *IPS* stands for the panel integration tests are based on Im, Pesaran and Shin (2000). The lag order was set to 2 (1) for the unit root test in level (first difference). The tests are distributed asymptotically N(0,1) and are one-sided. (**) indicates the 5% significance level, which is based on the critical value -1.64 for all tests.

Table 2 Pedroni Cointegration Tests

	1	***2***	***3***	***4***	***5***
	RHP RDIPC RMRATE POP HSTOCK RCOST RMDEBT RSP	*RHP RDIPC RMRATE POP HSTOCK RCOST*	*RHP RDIPC RMRATE RMDEBT RSP*	*RHP RDIPC RMRATE RMDEBT*	*RHP RDIPC RMRATE*
	No Trends	*No Trends*	*No Trends*	*No Trends*	*No Trends*
Panel v	-0.34	0.76	0.44	1.31	3.43**
Panel ρ	2.89	1.13	1.26	0.01	-1.69**
Panel *pp-t*	0.10	-0.59	0.50	-0.55	-1.75**
Panel t	-0.29	0.31	0.82	-0.58	-1.59
Group ρ	3.51	2.07	2.08	1.00	-0.52
Group *pp-t*	-0.62	-0.33	0.85	0.06	-1.14
Group t	-1.72**	0.28	-0.18	-1.49	-1.97**
	With Trends	*With Trends*	*With Trends*	*With Trends*	*With Trends*
Panel v	0.06	0.88	-0.15	0.20	1.96**
Panel ρ	3.62	1.53	2.55	1.64	-0.06
Panel *pp-t*	0.02	-1.11	1.63	0.81	-0.74
Panel t	-0.86	-2.68**	2.27	1.10	-0.84
Group ρ	4.31	2.65	3.28	2.38	1.05
Group *pp-t*	-0.90	-0.53	1.90	1.31	-0.11
Group t	-2.77**	-2.22**	1.00	0.30	-0.98

Notes: The null hypothesis for all tests is ‘no cointegration relationship for all countries.’ The alternative for the four panel tests is ‘there is a cointegration relationship and the degree of autocorrelation of the residuals of the cointegration relationships is the same across the countries.’ The alternative for the three group statistics is that ‘‘there is a cointegration relationship and the degree of autocorrelation of the residuals of the cointegration relationships may differ across countries.’ All tests are distributed asymptotically N(0,1) and are one-sided. (**) indicates the 5% significance level, which is based on the critical value -1.64 for all but the panel v-stat for which the upper side 1.64 value is used. See Pedroni (1999) for details.

Table 3 House Price Equation – Alternative Specifications

	1	*2*	*3*	*4*
DRHP(-1)	0.53*** (0.06)	0.56*** (0.06)	0.43*** (0.06)	0.40*** (0.07)
DRDIPC	0.58*** (0.14)	0.54*** (0.15)	0.39*** (0.13)	0.36*** (0.14)
DRMRATE(-1)	-0.48*** (0.18)	-0.42** (0.18)	-0.36** (0.15)	-0.38** (0.16)
DRCOST	0.28*** (0.09)	0.27*** (0.09)	0.22*** (0.07)	0.20*** (0.07)
DRCOST(-1)	-0.22** (0.09)	-0.25*** (0.09)	-0.06 (0.07)	-0.07 (0.08)
DRMDEBT			0.49*** (0.11)	0.62*** (0.16)
DRSP			0.04*** (0.02)	0.03* (0.02)
RHP(-1)	-0.13*** (0.02)	-0.21*** (0.03)	-0.15*** (0.02)	-0.23*** (0.03)
RDIPC(-1)	0.13** (0.05)	0.15* (0.08)	0.19*** (0.06)	0.35*** (0.09)
RMRATE(-1)	-0.17 (0.12)	-0.32* (0.14)	-0.28*** (0.10)	-0.24* (0.12)
RMDEBT(-1)			0.03* (0.017)	0.07** (0.03)
RSP(-1)			0.002 (0.001)	0.01 (0.01)
POP(-1)	0.37*** (0.12)	0.44 (0.29)	-0.02 (0.15)	0.41 (0.30)
HSTOCK(-1)	-0.18* (0.10)	-0.18 (0.15)	-0.05 (0.11)	-0.12 (0.17)
RCOST(-1)	0.01 (0.02)	0.07 (0.05)	-0.04 (0.03)	-0.03 (0.06)
Long-Run Elasticities				
RDIPC	1.0	0.7	1.3	1.5
RMRATE	-1.3	-1.5	-1.9	-1.0
RMDEBT			0.2	0.3
RSP			0.01	0.4
POP	2.8	2.1	-0.1	1.8
HSTOCK	-1.4	-0.9	-0.3	-0.5
RCOST	0.1	0.3	0.3	-0.1
Estimation Method	OLS	OLS	IV-2SLS	IV-2SLS
Country Trends	no	yes	no	yes
R- squared	0.46	0.49	0.59	0.62
Obs	358	358	334	334
Autocorrelation	6.4	5.3	2.3	3.2

Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV = instrumental variables. DRMDEBT is instrumented with DRMDEBT(-1). The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively.

Table 4 House Price Equation: Robustness of 'Preferred' Specification

	1	*2*	*3*	*4*
DRHP(-1)	0.43*** (0.06)	0.41*** (0.06)	0.50*** (0.07)	*0.42*
DRDIPC	0.37*** (0.13)	0.40*** (0.13)	0.40*** (0.16)	*0.33*
DRMRATE(-1)	-0.38** (0.15)	-0.41*** (0.15)	-0.41*** (0.15)	*-0.09*
DRCOST	0.23*** (0.07)	0.21*** (0.07)	0.18** (0.07)	*0.18*
DRMDEBT	0.47*** (0.09)	0.59*** (0.12)	0.41** (0.19)	*0.41*
DRSP	0.05*** (0.015)	0.03** (0.014)	0.04** (0.01)	*0.02*
RHP(-1)	-0.15*** (0.02)	-0.24*** (0.03)	-0.24*** (0.03)	-0.25*** (0.05)
RDIPC(-1)	0.14*** (0.05)	0.36*** (0.09)	0.29*** (0.09)	0.37** (0.15)
RMRATE(-1)	-0.30*** (0.11)	-0.27** (0.12)	-0.33** (0.13)	-0.66*** (0.23)
RMDEBT(-1)	0.03** (0.01)	0.07*** (0.02)	0.07** (0.03)	0.05 (0.04)
Long-Run Elasticities				
RDIPC	0.9	1.5	1.2	1.5
RMRATE	-2	-1.1	-1.4	-2.6
RMDEBT	0.2	0.3	0.3	0.2
Estimation Method	IV-2SLS	IV-2SLS	IV-2SLS	IV-PMG
Individual trends	no	yes	yes	yes
R- squared	0.59	0.63	0.65	0.66
Obs	334	334	329	334
Autocorrelation	1.5	1.8	1.5	12.6

Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV-2SLS = instrumental variables two stage least square. *DRMDEBT* is instrumented with *DRMDEBT(-1)*. The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively. The last column shows the results of the Pooled Mean Group (PMG) model with country-specific short-run dynamics, whose simple average is shown in *italics*.

Table 5 House Price Equation: Splitting the Sample Period

	1		*2*	
	Pre-1990	Post-1990	Pre-1990	Post-1990
DRHP(-1)	0.37*** (0.08)	0.63** (0.11)	0.35*** (0.08)	0.59* (0.12)
DRDIPC	0.52** (0.18)	0.06 (0.20)	0.48** (0.20)	0.12 (0.21
DRMRATE(-1)	-0.37** (0.18)	-0.60** (0.28)	-0.39** (0.19)	-0.68* (0.37)
DRCOST	0.25*** (0.08)	0.18 (0.15)	0.25** (0.09)	0.15 (0.14
DRMDEBT	0.64** (0.14)	0.04 (0.21)	0.77*** (0.17)	0.13 (0.24
DRSP	0.05** (0.02)	0.04** (0.02)	0.03 (0.02)	0.04** (0.02)
RHP(-1)	-0.17*** (0.03)	-0.17*** (0.03)	-0.24*** (0.03)	-0.24*** (0.03)
RDIPC(-1)	0.21*** (0.05)	0.20*** (0.05)	0.37*** (0.09)	0.37*** (0.09)
RMRATE(-1)	-0.43** (0.15	-0.46* (.28)	-0.33* (0.17	-0.64* (0.33)
RMDEBT(-1)	0.06*** (0.017)	0.05*** (0.017)	0.08*** (0.03)	0.07** (0.03)
Long-Run Elasticities				
RDIPC	1.2	1.2	1.5	1.5
RMRATE	-2.5	-2.7	-1.4	-2.7
RMDEBT	0.4	0.3	0.3	0.3
Estimation Method	IV-2SLS		IV-2SLS	
Individual trends	no		yes	
R- squared	0.59		0.61	
Obs	334		334	
Autocorrelation	2.1		3.2	

Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV-2SLS = instrumental variables two stage least square. *DRMDEBT* is instrumented with *DRMDEBT(-1)*. The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively.

Table 6 House Price Equation: Pre and Post Financial Liberalization (FL)

	1		***2***	
	Pre-FL	Post-FL	Pre-FL	Post-FL
DRHP(-1)	0.34***	0.51***	0.28***	0.55***
	(0.08)	(0.08)	(0.09)	(0.09)
DRDIPC	0.79***	0.05	0.69***	0.12
	(0.20)	(0.16)	(0.22)	(0.17)
DRMRATE(-1)	-0.23	-0.41*	-0.19**	-0.60**
	(0.18)	(0.37)	(0.23)	(0.30)
DRCOST	0.13	0.31**	0.19**	0.22*
	(0.08)	(0.13)	(0.09)	(0.13)
DRMDEBT	0.47***	0.41**	0.71***	0.42**
	(0.14)	(0.17)	(0.20)	(0.18)
DRSP	0.03	0.04**	0.01	0.05**
	(0.03)	(0.02)	(0.03)	(0.02)
RHP(-1)	-0.17***	-0.18***	-0.26***	-0.25***
	(0.03)	(0.03)	(0.04)	(0.03)
RDIPC(-1)	0.16***	0.16***	0.39***	0.39***
	(0.05)	(0.05)	(0.09)	(0.09)
RMRATE(-1)	-0.43***	-0.39*	-0.28*	-0.54**
	(0.15)	(0.25)	(0.17)	(0.26)
RMDEBT(-1)	0.03**	0.02	0.09***	0.07**
	(0.015)	(0.015)	(0.03)	(0.03)
Long-Run Elasticities				
RDIPC	0.9	0.9	1.5	1.5
RMRATE	-2.5	-2.2	-1.1	-2.2
RMDEBT	0.2	0.1	0.3	0.3
Estimation Method	IV-2SLS		IV-2SLS	
Individual trends	no		yes	
R- squared	0.61		0.64	
Obs	334		334	
Autocorrelation	0.6		1.1	

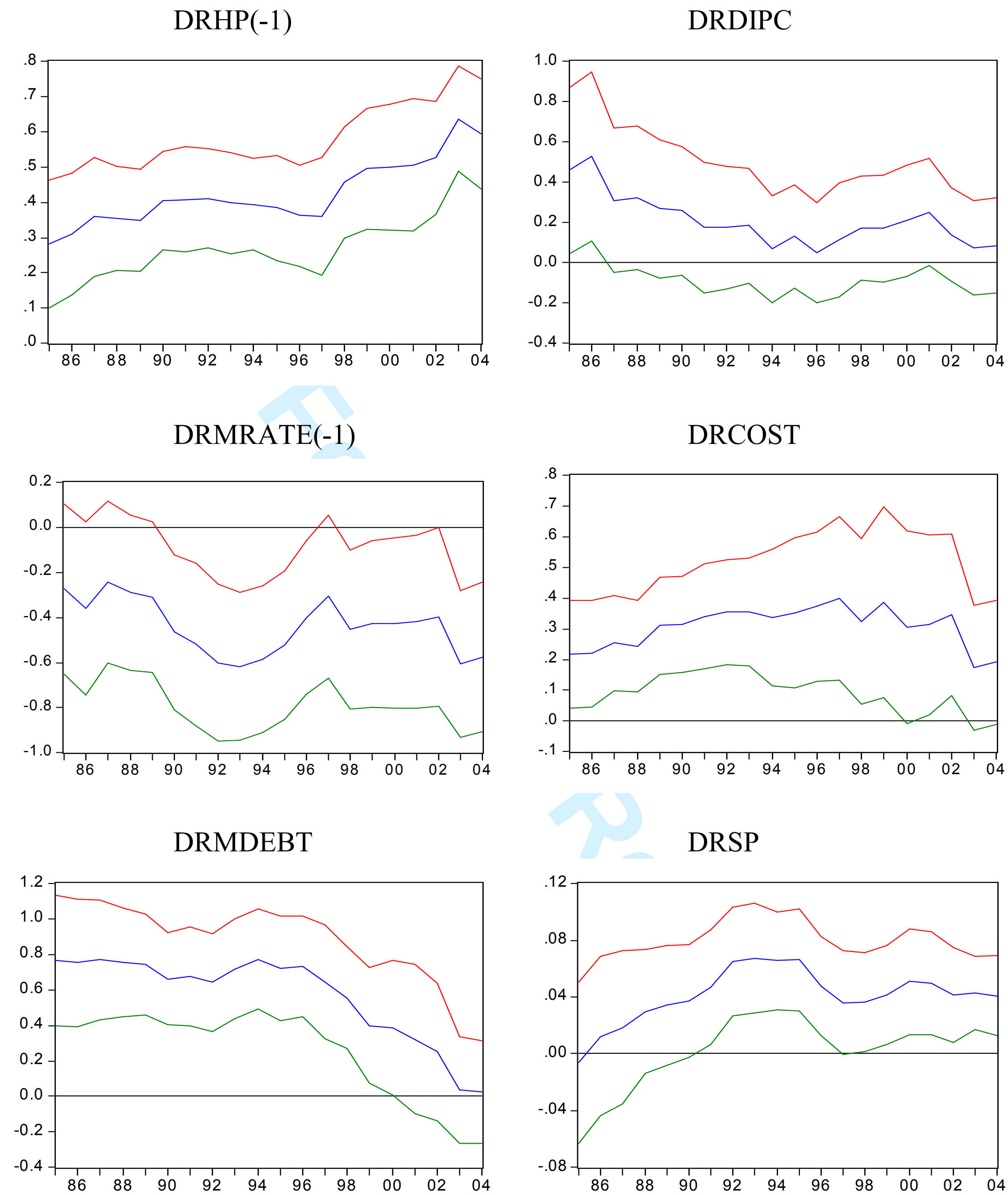
Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV-2SLS = instrumental variables two stage least square. *DRMDEBT* is instrumented with *DRMDEBT(-1)*. The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively.

Table 7 House Price Equation: Additional Results

	1	*2*	*3*	*4*
	Pre-1990	Post-1990	Pre-FL	Post-FL
DRHP(-1)	0.36*** (0.09)	0.59*** (0.10)	0.31*** (0.10)	0.49*** (0.09)
DRDIPC	0.44** (0.21)	0.08 (0.15)	0.62** (0.24)	0.11 (0.16)
DRMRATE(-1)	-0.37* (0.22)	-0.58*** (0.21)	-0.29 (0.22)	-0.42** (0.21)
DRCOST	0.23** (0.10)	0.19 (0.12)	0.15 (0.10)	0.30 (0.14)
DRMDEBT	0.71*** (0.18)	0.02 (0.18)	0.73*** (0.22)	0.39** (0.18)
DRSP	0.03 (0.03)	0.04** (0.02)	-0.01 (0.03)	0.05** (0.02)
ECM(-1)	-0.20*** (0.04)	-0.19*** (0.03)	-0.31*** (0.05)	-0.15*** (0.03)
Estimation Method	IV-2SLS	IV-2SLS	IV-2SLS	IV-2SLS
Individual trends	No	no	no	no
R- squared	0.53	0.70	0.50	0.64
Obs	169	165	130	204
Autocorrelation	5.2	0.3	5.1	2.8

Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV-2SLS = instrumental variables two stage least square. *DRMDEBT* is instrumented with *DRMDEBT(-1)*. The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively.

Figure 1: Rolling Regressions: Short Run Coefficients of House Price Equation



Notes: Rolling regressions of preferred specification with imposed long run relationship as in columns 1 and 2 of Table 9. The rolling window is fixed at T=15. The middle blue line is the point estimate of the correspondent coefficient. Confidence bands are based on ± 1.6 standard errors.

Financial Liberalization and House Price Dynamics in Europe

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Abstract

This paper investigates the determinants of house prices in a sample of European countries over the period 1970-2004. Focusing on the role of financial liberalization, we find that it has mainly affected the short term dynamics of residential prices. In particular, the impulse effects on house prices of income and mortgage debt have become smaller. On the other hand the effects of interest rates, past house prices and, to a lesser degree, stock market have strengthened. In other words, there seems to have been a certain "de-linking" of short term house price dynamics from income, whereas the housing market may have become more similar to a financial asset market, with interest rates and expectations of capital gains playing a more prominent role.

Keywords: house prices, financial liberalization, cointegration, error correction mechanism.

JEL Codes: C2, G1, R21.

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I. Introduction

Economic commentators have long attributed movements of housing prices to mortgage market conditions. Despite this widespread conviction, the empirical evidence on the importance of financial factors on house price dynamics is relatively thin and often difficult to interpret, especially when it comes to studies outside the U.S. and the U.K.

The earlier country or multi-country studies of house price dynamics focused primarily on the interest rate channel (see for example Drake (1993), Kennedy and Andersen (1994), Englund and Ioannides (1997), Kasparova and White (2001), McGibany and Nourzad (2004)). For the most part, interest rates (or the user cost of capital) were found to have a statistically significant, though quantitatively limited impact on house prices. Other financial variables and, in particular bank credit, have also been introduced early on in country specific models, particularly for the U.K. (see for instance Hendry (1984) and Meen (1990)), typically, on the grounds that there may be credit rationing. A certain coincidence in recent years between credit cycles and house prices in countries other than just the U.K. has brought the possible relation between the two back into the limelight. Tsatsaronis and Zhu (2004), IMF (2004), Lecat and Mésonnier (2005), Ott (2006) and others have explored the role of bank credit in house price models covering several countries.

In general, credit quantity variables in these studies turned out to be statistically significant, though, in many cases endogeneity may have been an issue of concern.[1] The construction of alternative measures of "credit availability" or "excess liquidity", apart from raising additional methodological and measurement issues, has not been empirically very successful. From the theoretical point of view, the lack often of a well defined conceptual framework that would explain the introduction of credit quantity variables in the empirical equation makes the interpretation of the results more difficult. Perhaps even more to the point, there seems to be a significant gap between, on the one hand, the theoretical discussions on structural changes in the mortgage markets and the financial system in general and, on the other, the little emphasis the empirical literature has placed in detecting any changes over time in the relation between house price dynamics and financial variables. Noticeable exceptions are provided by Muellbauer and Murphy (1997) who argue that financial liberalization of mortgage markets led to notable shifts in house price behaviour making real interest rates

[1] Hofmann (2003) examined the two-way relationship of property prices and bank lending in a sample of 20 countries. His evidence suggests that the long-run relationship runs from property prices to bank lending, while in the short run causality may be running both ways. See also Hofmann (2004).

relatively more important. A similar argument has been made by Iacoviello and Minetti (2003) who have estimated that in Finland, Sweden and the U.K. the sensitivity of house prices to short term interest rates has increased over time, probably as a result of the process of financial deregulation. This issue received some attention also in IMF (2008).

A brief digression to the conceptual framework underlying most empirical research on house prices may be useful at this point. Textbook analysis of housing decisions is typically based on simple assumptions about the financial side, namely that individual households face either a perfectly elastic or a perfectly inelastic supply of credit. The former is equivalent to the "Jorgenson" type of model in corporate investment. The perfectly inelastic credit supply (when debt or the debt-asset ratio exceeds a certain level) is instead the building block for the familiar financial accelerator models. Though not particularly realistic, both assumptions simplify considerably the modelling of household decisions and each provides an explanation for including either price (interest rate, user cost of capital) or credit quantity variables in empirical relationships. A more subtle difference between the two is that the "Jorgenson" type of models are essentially models about stocks or long run plans, while the financial accelerator models are about flows or the short run adjustment from one optimal stock position to another.

As might be expected, the introduction in the household's optimisation of a credit supply function with both a perfectly elastic section and an upward slopping part combines elements of both the "Jorgenson" type of investment models and the financial accelerator models (e.g. Steigum, 1983). A credit supply function of this type can capture the idea that when the debt-value ratio increases above a certain threshold, the household has to pay a rising premium over and above what the "going" market mortgage interest rate is for the most credit-worthy borrowers.[2] Households' housing optimal plans depend in this extended model both on the "going" mortgage interest rates and on the credit standards and credit constraints that affect the premium function that defines what the individual household pays on top of the "going" mortgage rate. Other things equal, a higher debt-value ratio would signal in this case that a household is located more to the right of the upward credit supply function and hence facing higher marginal "effective" mortgage costs.[3] By "effective" mortgage cost, we mean in this context the cost of both the interest rate and any additional contractual costs. Perhaps more

[2] A premium of this type may take the form of a higher mortgage interest rate or a non-interest rate cost incurred for example when the household is asked for extra collateral, fees, an additional insurance or is faced with less convenient contractual mortgage terms. At the limit, credit may be rationed (for example when the debt-asset ratio is around 1), at which point the premium function becomes perfectly inelastic.
[3] An example of such a model is available on request to the authors.

interesting for the empirical work and less obvious a priori is the suggestion that the "going" mortgage interest rate and the credit standards or debt-value ratio may enter differently in the short and long run relation.

The intuition behind this last suggestion is straightforward. Consider, for example, what would happen if, other things being equal, a household were given access to a higher debt-asset ratio at the same interest rate. If the household were planning to accumulate housing assets and did not have sufficient own funds, the access to more debt could induce it to anticipate some of its housing purchases. A younger household for example would be less constrained by its current income and could acquire its own house sooner; an older household could "move up" the housing ladder faster. While the short run housing demand is thus affected, the long run housing plan of each household is likely to be little changed by the easier access to debt. In planning for the longer run the household needs to keep an eye on its expected "permanent" income and borrow accordingly. Flow constraints and rising marginal costs of debt are important primarily for the ability of households to "smooth" short run income variations, but less so when it comes to planning their longer run portfolio that includes the housing assets.[4]

Interestingly for our purposes, the above distinction between short and long run effects of different financial factors has also some potential implications on how structural changes in the mortgage market may affect housing demand. As discussed below, mortgage market liberalisation is generally thought to have affected mostly the "premium" requested by less credit-worthy households. If this premium enters primarily the short term dynamics of housing demand, as mentioned above, financial liberalisation could have had a stronger effect on the short rather than the long run relation of house prices and financial factors.

Thus, to summarise, the above discussion suggests that, when modelling house price dynamics, one needs to, first, consider both interest rate and credit quantity variables; second, allow for differences in the short and long run effects of the two type of variables; third, consider the possibility that these relations may have changed over time as financial market liberalisation has progressed, in particular, for what concerns the short run dynamics. This paper takes another look at all three empirical issues.

[4] There may still be some long run effects from credit conditions other than the mortgage interest rates. For instance, in the above example, even though the long run housing plans of individual households do not change when credit constraints are relaxed, it is still true that younger people will move out of the family and acquire larger houses earlier in their life cycle. Thus, a relaxation of credit constraints may lead to permanently higher aggregate demand for housing services, though its main effect may concern the short run.

The remainder of the paper is organized as follows. The next section describes the dataset and the model specification. Section 3 provides the estimation results of the benchmark model whereas Section 4 looks at the possible effects of financial liberalization. Finally, Section 5 concludes.

II. The Dataset and Model Specification

As is the case with many of the house price studies in Europe, the empirical model is heavily conditioned by data availability. As can be seen from the Annex, data sources are disperse and data is of varying quality. We use only annual data, both because we believe these to be more reliable and because we thus have a better coverage of 11 EU countries over time.

We use a standard error-correction model (ECM), which permits a relatively straightforward estimation of short and long run effects in a single equation. In particular, we start from the following general unrestricted ECM specification:

$$(1) \qquad \Delta y_{it} = \mu_i + \sum_{j=1}^{2} \lambda_j \Delta y_{i,t-j} + \sum_{j=0}^{2} \Delta \mathbf{X}_{i,t-j} \boldsymbol{\delta}_j + \alpha y_{i,t-1} + \boldsymbol{\beta}' \mathbf{X}_{i,t-1} + \varepsilon_{it}$$

where $t = 1, 2, ..., T$ and $i = 1, 2, ..., N$, μ_i represents the country-specific intercept or fixed effect, $\mathbf{X}_{i,t}$ is a $1 \times k$ vector of variables x_{it} that cointegrate with y_{it}, α is the error-correction coefficient determining the speed of adjustment to the long-run equilibrium, $\boldsymbol{\beta}$ the vector of (non-normalised) long-run coefficients, and ε_{it} the error term. Direct estimation of equation (1) allows us to obtain both the short-run dynamics and the long run response (elasticity) of y_{it} to an independent variable x_{it}. The latter is directly estimated (and reported at the bottom of the tables with the results) from the estimates of α and of the respective long run parameter β as follows: -β/α.[5]

The variables included are all those suggested by the theoretical model above and, more or less, standard in the literature. Beside the "real" house prices (*RHP*), our dependent variable, the vector $\mathbf{X}_{i,t}$ includes the real disposable income per capita (*RDIPC*), the real mortgage rate (*RMRATE*), the real stock of mortgage debt per capita (*RMDEBT*) and the total population over 24 years of age (*POP*), the real stock market index (*RSP*) as a possible (rather imperfect) proxy of financial wealth and two supply side variables, the residential

[5] We opt for a single-equation rather than a two-stage ECM model, because in finite samples, under the presence of cointegration, the bias in the estimates of the cointegrating relationship is larger in static models than in dynamic models (Banerjee *et al*, 1986).

housing stock (*HSTOCK*), and the "real" construction cost index (*RCOST*). Typically, in these relations, housing supply is considered to be inelastic in the short run. Reduced form housing price equations are therefore basically inverse demand equations with housing capital added in the long run relation to capture the long run supply effects. Even though housing capital may be taken as given in the short run, variations in construction costs can affect short term house price dynamics if they affect expectations of prices of new houses in the future. All variables other than the interest rate are in logs and income, debt and capital stock variables are normalised with the population over 24 years of age. An alternative to the population variable could have been the number of households, but reliable data is only available from censuses with five year intervals or more.[6] The mortgage debt variable is often introduced on the grounds that there may be quantitative credit constraints but, as discussed above, it can be more generally interpreted as a proxy of higher marginal "effective" cost of mortgage debt.

Before implementing the ECM model, we test for the order of integration of the single variables used in the estimation. For this purpose, two sets of assumptions can be made for which two standard panel procedures are available. The first test (Levin, Lin and Chu, 2002 - LLC) employs the null hypothesis of a common unit root process across cross-sections, implying that the persistence or autoregressive parameter is the same across countries. The second test (Im, Pesaran and Shin (2003) - IPS) allows for individual unit root processes meaning that the autoregressive coefficients vary across-sections and combines the individual unit root tests to derive a panel specific statistic. From the panel unit root tests (Table 1), it can be seen that most variables are found to be integrated of order one in level. The only relevant exception is the LLC test, which indicates that *POP* is stationary in level. All in all, we do not have enough evidence to discard the presence of a unit root in all the variables under investigation, and in what follows we will test the presence of cointegration between these variables in level.

Table 2 displays the results of the panel cointegration tests of Pedroni (1999) and Kao (1999). The Pedroni tests are based on a panel unit root test of the residuals from a regression which allows for heterogeneous slope coefficients, fixed effects with (or without) individual specific deterministic trends. These tests have the advantage of allowing the presence of heterogeneity of the co-integrating vectors, but the obvious drawback is that in the presence of small T, the

[6] Additionally, there could be a spurious correlation between house market conditions and the number of households, if the former influence the timing young people leave the parents' house, as mentioned above in footnote 4.

country-specific estimates may be subject to substantial biases, above all when a large number of non-stationary variables are included. As a result, we also implements Kao tests. The latter follow the same basic approach as the Pedroni tests, but specify cross-section specific intercepts and homogeneous slope coefficients in the cointegrating regression. Both the Pedroni and the Kao statistics are constructed to test the null hypothesis of no cointegration.[7]

Table 2 shows these cointegration tests for the specifications either with fixed effects or with fixed effects and individual linear trends. With the only exception of the group-*t* test, no test rejects the null of no cointegration in the general specification in column (1) (*RHP*, *RDIPC*, *RMRATE*, *POP*, *HSTOCK*, *RCOST*, *RMDEBT* and *RSP*). Columns (2), (3) and (4) test for the presence of cointegration between a subset of the variables included in the general specification. Again, except for the panel and group *t*-statistics of the standard model accounting for demographic and supply conditions, no test supports the presence of cointegration. Finally, column (5) shows the results for the basic three-variable model in *RHP*, *RDIPC* and *RMRATE*. Four tests reject the null of no cointegration in the specification without individual linear trends. From the above results, Pedroni tests suggest the presence of cointegration for more parsimonious models. Kao tests, on the other hand, provide evidence of cointegration in all specifications. All in all, we take these tests to suggest that we should start with a rather general specification, including a wider range of the above variables, particularly, if the focus is with the pooled panel regressions, as is here the case.

Before discussing the main results, two econometric aspects are worth mentioning from the outset. Firstly, due to the annual frequency of the dataset and the resulting problems of degrees of freedom which may result from the estimation of country-specific models, we will impose homogenous parameters across countries. At the same time, however, we allow for heterogeneity by including fixed effects and, as a robustness check, also individual linear trends. The former captures the impact of all time-invariant determinants of house price growth, whereas the latter accounts for potentially omitted trending determinants of house prices (see below for a discussion). For comparison, we also present the results from a regression where we allow country heterogeneity in short term dynamics. The second econometric aspect refers to the choice of estimation method. The use of fixed effects and a lagged term in an ECM specification raises the question whether our estimates are

[7] Gutierrez (2003) shows that the power of Kao and Pedroni tests is sensitive to the time and cross-country dimension of the panel. As a result, these tests should be interpreted with caution and assessed in combination with our ECM strategy.

inconsistent as is the case in typical dynamic panel models with a small time dimension. However, the typical Arellano-Bond methodology applied to dynamic panel data models is designed for samples with a large cross-section, which is not the case in our dataset, and, more importantly, our panel is large enough in the time dimension, suggesting that the use of the ordinary fixed effects model is more appropriate in our case.

III. Estimation Results of Benchmark Model

Table 3 presents the empirical results from ECM models. We start with the standard benchmark model, of the "Jorgenson" type, where the only explicit financial variable is the real mortgage interest rate. The other independent variables are the real disposable income per capita, the population over 24 years of age, the housing capital stock per capita and the real construction cost index. The disposable income variable may capture in the short run both the change in expected life cycle income and the possible effects of additional internal finance. In a "Jorgenson" type of world, the availability of internal finance should not be of relevance in principle, but changes in disposable income are still likely to have an effect on housing demand via the expectation channel.

In a first general specification (not presented here) we introduced all independent variables in both lagged levels and first differences to capture long and short run effects. We have experimented with contemporaneous and lagged first differences. It turned out that the contemporaneous first difference of income, the lagged first difference of real mortgage rates and the contemporaneous and lagged difference of construction costs sufficiently capture the short term dynamics. Housing stock and population enter only in the long run relation.[8]

Column 1 in Table 3 presents the estimation results from the "trimmed" version of the benchmark model, after having dropped the statistically non significant short term effects. All estimated coefficients have the expected signs and reasonable orders of magnitude. In the *short run*, an increase in real income of 1% is estimated to raise real house prices in the same period by close to 0.6%. An increase of the mortgage interest rate by 100 basis points is estimated to bring down real house prices by close to 0.5% with one year delay. A rise of real construction costs is found to have a positive but short lived effect, which is largely reversed

[8] In preliminary estimates we have also added year fixed effects. The inclusion of the latter, however, makes the effect of the real interest rate in the long run insignificant. This could well be a reflection of the fact that real interest rates have had broadly similar long term patterns in most EU countries, though changes have not always been synchronised. The short run effect of interest rates remains statistically significant and quantitatively important. The rest of the results changed little when time dummies were present.

a year later. A significant part of a house price increase/decrease would seem to carry over to the next year. The "persistence" coefficient (of the lagged dependent variable) is estimated to be above 0.5. In the *long run*, the main effects come from the disposable income and population variables. The elasticity of real house prices with respect to income is estimated to 1, that with respect to population to 2.8. The elasticity with respect to housing capital stock is -1.4, although only statistically significant at 10% level. The estimated semi-elasticity with respect to the real mortgage rate is -1.3 and the elasticity with respect to real construction costs is 0.1. Both, however, are not statistically significant. All in all, these findings are qualitatively consistent with a number of recent empirical studies on house price determination (see OECD, 2005 for a survey).

The model in column (1) shows signs of autocorrelation (see bottom of the table). Moreover, the residuals from individual countries show some long term pattern. The residuals from Germany in particular have a clear negative trend. Finally, for some countries, there seems to be much more noise in the data in the first years of the sample, possibly due to more measurement errors in that period. Italy and Belgium present the clearest cases of this. In the following regressions, we consider these issues in more detail.

A priori, we would expect that some of the above problems, particularly those concerning autocorrelation and the long term patterns in the residuals, may be due to omitted variables and/or systematic measurement errors. Even before turning to the financial side, we can think of different potential omitted factors, some of them concerning the supply side, such as construction land availability and cost, innovations in construction technology, changing social habits, urbanisation and regulations etc. Further, systematic measurement errors may arise among other things because of failing to correct prices for changes in house characteristics in terms of quality, size, location or amenities. This type of factors and errors are very hard to measure, but one may reasonably assume that they are likely to have changed more or less monotonically over a number of years, though not necessarily with the same rate across countries. If so, a country specific trend variable could be expected to capture much of their effect. The drawback of course is that by effectively de-trending our data we are removing a lot of variation, potentially making the long run coefficients ill-determined. Therefore, we present results from both regressions with and without country-specific trends.

Like ordinary dummy variables, country-specific trends do not tell us of course much about the true underlying factors driving the long run relations.[9]

Thus, in column (2) of the table, we re-estimate the model of column (1) introducing also country specific deterministic trends. The trend coefficients are statistically significant ($\chi^2(11)=49$), though it should be said that much of the explanatory power of the trends comes from Germany. In terms of the rest of the estimates, the introduction of country specific trends changes somewhat the short term dynamics and the long run elasticities (which are now *conditional on the trends*). Qualitatively, however, previous results change little. The statistical significance of the coefficients in the long run relation does change, however, and we can now reject the hypothesis that the long run effect of interest rates is zero. The coefficient of the population term, on the other hand, turns out to be statistically insignificant. Evidently, the trend variables capture some of the effect of the population term. Finally, even with trend variables we reject the null hypothesis of no autocorrelation at the 10% level.

We consider next amending the financial side of the model. Hence, we depart from the standard "Jorgenson" type of model and introduce two extra financial variables, the mortgage debt per capita and the stock market index (both in real terms). Stock market prices affect the households' wealth, and thus the availability of internal financing, but could also capture expectations about the future (Sutton, 2002; Kakes and van den End, 2004). They may also capture the opportunity cost of investing in housing (to the extent that housing is treated as a normal portfolio decision by households), though in this latter case there should be negatively related with real house prices. Mortgage debt reflects the external financial conditions faced by households, on the credit supply side, but also capture changes in the demand for credit. We use, therefore, the lagged value of mortgage debt growth as instrument.[10]

Columns (3) and (4) of Table 3 present respectively the amended model without and with the trend variables. In both cases, the introduction of the two financial variables improves significantly the explanatory power of the model. Autocorrelation tests also improve.

[9] Hassler (1999) shows that a significant time trend may indicate omission of a variable with a linear trend in mean from the cointegrating regression. In this respect, the inclusion of trends may help to hint at miss-specification.

[10] We also experimented with a number of additional instruments like the lagged change in long run interest rate, the lagged real disposable income growth and the lagged change in private debt per capita though, in practice, these made relatively little difference to the results. Note also that we lose 34 observations due to the unavailability of mortgage debt data. Re-estimating the model in columns (1) and (2) with the smaller data set leaves most of the results unchanged.

The estimated coefficients confirm the positive relation of house prices with both mortgage debt and stock prices in the *short run*. Quantitatively, the short run effect of stock market prices on house prices is relatively small. This is not surprising given the presumambly small share of equity in the typical household portfolio in our sample. Instead, the role of mortgage financing is quantitatively important. A 1% rise in mortgage debt is related to roughly 0.5%-0.6% short run increase in house prices, ceteris paribus. The rest of the short run coefficients also change with the introduction of the two financial variables. Most noteworthy is the drop in the coefficient estimates for the lagged dependent variable and of income in the short run. In other words, part of what appeared previously as "persistence" in house price dynamics or as an income effect, is now explained as an effect on house prices from changes in credit availability. The estimated impulse effect of interest rates also falls somewhat below -0.4.

In the *long run*, stock market prices turn out to be statistically insignificant, while mortgage debt is estimated to have a relatively moderate but persistently positive effect on real house prices (long run elasticity of about 0.2-0.3). When dropping mortgage debt from the long run relation, the long run semi elasticity of house prices with respect to interest rates rises by about 0.5 in both models (while that of income and the other variables remains largely unchanged). Mortgage interest rates and mortgage debt would seem to capture in part the same long run effect of "financial conditions" on house prices.

The long run elasticity with respect to income rises in this model close to 1.5. In contrast, the long run effect of population, capital stock and construction costs turn out to be statistically insignificant in both models. This does not necessarily mean that all of these factors have not played a role for long run house price developments. Capital stock and, to certain extent, population grow at a relatively stable rate year by year and this makes it difficult to get reliable estimates of their long run effect, especially when time trends are introduced. In some of the specifications population dynamics seem to play a role for long term house price developments. On the other hand, the statistical insignificance of construction costs and capital stock may also indicate that the main supply side factor may have been land availability (and cost), rather than the availability and construction cost of the buildings.[11] Whatever the case may be, we find that we can drop the population and supply side variables

[11] Having said that, it is possible that construction bottlenecks could have caused temporary increases of costs and prices, as the short run construction cost coefficient suggests. The (rather poor) information available on land prices suggests that these have tended to increased much faster over the long run both compared to house prices and, even more so, compared to construction costs (see ECB, 2003).

from the long run relation with little effect on the rest of the estimation coefficients and this is what we do in the rest of the empirical investigation.

Summarising so far, we can say that there is a strong case for amending the standard ("Jorgenson type") house price model by introducing mortgage debt (and stock prices). Short term house price dynamics, in particular, seem to have been driven by financial factors (interest rates, mortgage debt, stock market prices), as well as by variations in income and construction costs. Point estimates vary somewhat from specification to specification, but qualitatively the results are robust to changes in the model. In the long run, we find that income has been the main driving factor. The long run elasticity of house prices with respect to income is estimated between 1 and 1.5. The estimated semi-elasticity of house prices with respect to interest rates is relatively low, somewhere between -1 and -2, with respect to mortgage debt is around 0.3. Country-specific deterministic trends could be capturing omitted variables in the long run relation, possibly related to supply and demographics.

The "preferred", more concise model (without and with trends) is presented in the first two columns of Table 4. The same comments apply as above. The rest of Table 4 shows some variations of the "preferred" model. In column 3, we re-estimate the model (with the trends) lagging the mortgage debt instruments by two periods to ensure that we are not capturing any feedback from house prices to mortgage debt. The estimate of the impulse effect of debt is always statistically significant and quantitatively important, albeit somewhat lower (compared to that in column (2)). All the remaining short and long dynamics are similar, though the "persistence" coefficient (of the lagged dependent variable) rises again to 0.5. This interaction between the short term house price dynamics attributable to changes in the mortgage debt and the "persistence" in house price inflation is of some interest as will be seen in the next section.

In column 4 of Table 4 we estimate the model allowing for heterogeneous dynamics in the different countries. In particular, the short run terms are country specific, while we pool the long term coefficients. The main difference in these estimates compared to our preferred model in column (2) concerns the effect of the mortgage interest rate. The new coefficient estimates suggest that, in the short run, the negative effect of mortgage interest rates may be smaller, but the long run elasticity is actually higher. Other than that, the point estimates, particular in the long run, remain relatively stable, though the coefficient associated with the real mortgage debt turns out to be statistically insignificant in the long run. The average across countries of the individual short term factors are also similar to the pooled models. This model, however, seems to suffer serious problems of autocorrelation.[12]

IV. Possible Effects of Financial Liberation

So far, we have followed much of the existing empirical literature and assumed that the house price relation has remained stable over time. One of the most obvious reasons why this may not have been the case is the liberalisation of the financial system. The literature has extensively documented a number of structural changes in the financial system in general and in the mortgage markets in particular, over our observation period. Though changes have varied in form and in timing, there has been something of a common pattern in most EU countries. This broadly involved a move away from interest rate caps and quantitative constraints in the late seventies and eighties, a relaxation of the rules on the specialisation of credit institutions and a gradual deregulation of the mortgage markets mostly in the eighties and early nineties and, more recently, measures aimed at promoting consumer protection and mortgage debt securitisation. In some countries, there has also been a parallel move towards bank privatisation and a related market restructuring as well as a reduction of state activities/direct subsidies in promoting owner occupation, though often a strong bias towards owner occupation and mortgage credit remained (or was even strengthened) in the tax system (IMF (2000), ECB (2003), IMF (2008)).

Mortgage market liberalisation is believed to have made access to credit easier for a large number of households that were previously effectively excluded from the market. More competition and better credit rating techniques should have led mortgage lending institutions to give less weight on current income and wealth when evaluating the credit worthiness of a household and put more weight on factors signalling (rightly or wrongly) high future income. Moreover, with a wider variety of products available in the market and a more persistent marketing of these products by credit institutions, households, particularly young households, are thought to have been better able to find the mortgage products that best fit their income profile. Thus, they should have been less constrained by their current income and wealth and

[12] In preliminary analysis, we also re-estimated the preferred model (with trends) using Feasible Generalized Least Squares (FGLS), taking account of period-specific heteroscedasticity. As mentioned earlier, noise in data appears to be much higher in early periods, possibly because of measurement errors. With FGLS point estimates change somewhat, but results remain on the whole very much the same. Standard errors decrease for all coefficients.

would have had access to larger loan-to-value or debt-to-asset ratios for the same cost, other things being equal.

Unfortunately, it is very difficult to time precisely these changes or to find one or more indicators that could measure mortgage market "liberalisation" in different countries over a longer period of time. Most of the indicators we could think of either concerned one specific aspect of the market – indeed often they were market outcomes - that may or may not have been the result of "liberalisation" (e.g. loan-to-value ratios) or were unreliably measured over a longer period of time (e.g. mortgage market concentration or penetration) or both. A first attempt to estimate the direct short run effect of liberalisation measures using dummy variables constructed on the basis of information on mortgage market deregulation from ECB (2003) and Lacat and Mesonnier (2005) (see Annex) has given poor results. [13]

Clearly, one of the biggest problems with such an exercise is that of the correct dating of "liberalisation measures", assuming a single date does indeed exists. More likely, regulatory and other changes in the mortgage market have taken longer periods to complete and had gradual effects on market practices. Moreover, in view of what was said earlier, there is no reason to believe that such changes can be captured by a shift in the country-specific intercept of the house price model, with no effects on the rest of the relation between financial variables and house prices. If financial liberalisation has affected, as argued above, the underlying credit standards and constraints imposed by lenders, one should expect that they would affect the elasticity of house prices with respect to the financial variables. Moreover, in line with what was said in the first section, the change in credit standards and credit constraints would have affected first and above all the *timing* of housing purchases and less so the long run household portfolio. Thus, the effect of financial liberalisation on the short and long run dynamics of housing demand and housing prices could have well been different.

We look therefore at different sub-periods of our sample and check whether estimated changes in coefficients are consistent with what the literature on mortgage markets would suggest should have happened. Clearly, we can not exclude that any changes over time in short term dynamics and/or long term elasticities of the house price equation could have been

[13] In particular, we constructed a dummy which takes the value of 1 in the year such measures were implemented, and 0 otherwise. A second dummy was assigned a value of 1 after the major measure was applied, and 0 otherwise. We introduced the two dummies in the preferred model of columns 1 and 2 of Table 4 and found that they have a quantitatively small impact and are statistically insignificant. Varying somewhat the time frame (e.g. introducing dummies with a lag compared to a liberalisation measure and/or allowing each dummy to cover more than one year) did not provide any more interesting results. In all of the regressions, the rest of the estimated coefficients were unaffected by the introduction of these dummies.

the product of other unidentified structural changes, more or less common to all European countries. The results that follow, therefore, offer some indications/suggestions, but cannot be read as a formal test of the financial liberalisation hypothesis.

We rerun the "preferred" model (of column 1 and 2, Table 4) allowing the coefficients of all independent variables to change from 1990 onwards. The year 1990 is arbitrarily chosen as a possible "break point" because it divides our sample roughly half way. A priori, 1990 is not a bad choice since many countries completed important steps of their financial liberalisation programmes around that time. It should nevertheless be mentioned that using alternative breaking points gives very similar results. As further steps, below we also present results from regressions that allow the breaking point to vary from country to country as well as results from rolling regressions.

Table 5 presents the results of two regressions. The first provides separate estimates of the coefficients for the period before and after 1990 for the model without country-specific trends. The second does the same for the model with trends. Clearly, these models are over-parameterised, containing as they do, apart from trends, 11 fixed effects and 2x10 independent variables. Point estimates should therefore be considered with caution, though the direction of change of these coefficients before and after 1990 is potentially of interest.

The estimates suggest that *short term* house price dynamics have changed considerably. Though there are some differences in the estimated parameters of the two models, with and without trends, the essential message is the same. The most important changes observed in the estimated parameters after 1990 are the drop of the income impulse effect (from about 0.5 to about 0.1) and that of debt (from 0.7 to about 0.1) and the corresponding increase of the short run effect of an interest rate change (from about -0.4 to about -0.6) and the coefficient of the lagged dependent variable from below 0.4 to about 0.6).

While these changes in the short term dynamics of house prices are of interest on their own, it is important to note that the empirical *long run* relation between house prices, income, interest rates and mortgage debt turns out to be relatively stable between the two sub-periods of our sample.[14] In particular, the estimated long run elasticity of prices with respect to

[14] A Wald test does not reject the hypothesis of constant long run coefficients ($\chi^2(4)$=3.3, $\chi^2(4)$=1.5 in the two models respectively). This observation needs some qualification however. When the model is run separately for the sub periods, as is done below, we can observe some changes in the long run elasticities. In particular, it seems that at least in some specifications the long run elasticity with respect to income rises in more recent times, though it is more difficult then to directly compare point estimates from different models. Concerning the short run relation, we can reject the hypothesis of constant coefficients at 10% level in the model without trends

income and with respect to debt remained stable. There is no indication of a long run "de-linking" of house prices and income. The semi-elasticity with respect to interest rates would seem to have changed somewhat, but given that this coefficient is not very accurately estimated, we cannot reject that also this has remained constant between the two sub periods.

In line with what was discussed earlier, our tentative interpretation is that changes in financial structures had an impact primarily on short term dynamics, reducing, ceteris paribus, the marginal cost of mortgage debt (i.e. relaxing the credit standards that determine the "premium" a household has to pay as its indebtedness rises). The short run elasticity of house prices with respect to interest rates increased as a result.

While changes in financial structures led households to anticipate house purchases, longer run housing demand may not have been much influenced. Being able to borrow more and to borrow earlier in the life cycle can raise the speed with which households realise their housing plans. For example it can reduce the average age of first-time buyers, but in the longer run housing plans should not change much. Income growth would appear to remain the main factor affecting these plans in the long run.

The natural question that follows empirically is whether we should not allow also the error structure to vary from one sub-period to another, given that, as mentioned earlier, measurement and other errors may have also changed over the 35 years we are considering. Thus, in Table 6 we re-estimate the model separately for the two sub-periods (columns 1 and 2). Given the short time frame of each sub-period (and the reduced degrees of freedom), we comment only on the regressions without time trends. It should be said, however, that the absence of time trends makes adjustment to the long run appear much slower. Additionally, given the stability of the long run coefficients, for both sub-sample we include the same error correction term (ECM), which apart from house prices, includes income, mortgage interest rates and mortgage debt. We fix the respective elasticities at 1.1, -2.3 and 0.3, which are the long run coefficients estimated imposing the same cointegrating relationship for the two sub-periods.[15]

These regressions do not impose the same error structure and the same country fixed effects in the two sub periods. Nevertheless, the qualitative results are very similar to those of Table

($\chi^2(6)$=10.5), but not in the model with trends ($\chi^2(6)$=7.9), presumably because of the over-parametrisation of the latter.

[15] We have also tested for richer short term variables, including DRMRATE, DRDIPC(-1), DRCOST(-1), but they all turn out to be statistically insignificant. The shorter time periods and the fewer degrees of freedom do not allow for that much further experimentation.

5. One can see again that the factors entering the house price short term dynamics seem to have changed over time, with financial "price" variables (interest rate and to lesser extent share prices) being more important in recent years than was the case before 1990. Instead, the impulse effect of income and debt turn out to be statistically insignificant (and quantitatively smaller) in the more recent period.

In the last two columns of Table 6, we repeat the exercise, this time allowing for break points that vary by country using the dates of the major financial deregulation measures mentioned earlier (see Annex).[16] For most countries, the break point now appears earlier than 1990 and, indeed, for West Germany the whole sample (starting in the mid-70s) is now attributed to the post-liberalisation period. In our view, this makes it more difficult to interpret the results. With all caveats in mind, therefore, one may observe that the results outlined in first two columns seem robust to this alternative splitting procedure, the most noticeable difference being that the impulse effect of mortgage debt remains in these latter model high also in the post-liberalisation period, albeit reduced compared to the pre-liberalisation period.

As a final test, on the basis of the fact the exact time period when financial liberalization took place may not be know with precision ex ante, and that the impact of financial liberalization on market behavior may have been gradual, rather than immediate, we also estimate rolling regressions using a 15-year window. Here, due to the relatively short sample we keep imposing the same cointegrating relationship as in the first two columns of Table 5. Figure 1 provides the estimated coefficients of the short term dynamics. Although the wide confidence bands point to a high degree of uncertainty around the point estimates, the rolling coefficients are consistent with a gradual transition from the pre- to the post-liberalization period. The clearest changes seem to be the drop of the impulse effect of mortgage debt and an increase in the "persistence" factor (the coefficient of the lagged dependent variable). There seems to be also a gradual change in the impulse effect of income, mortgage interest rates and share prices along the lines mentioned earlier.

To summarise, one way of describing the changes observed in the short term dynamics is to say that pricing of housing assets has become more akin to that of financial assets, i.e. their demand being more influenced by interest rates and past capital gains (feeding through

[16] For reasons of consistency, we actually follow again the same two step procedure, whereby we first estimate this model in a similar way as in Table 5, only now with country specific break points, and then use the long run coefficients of that model to construct the ECM variable. The long run elasticities from the first step estimation with country-specific break points are 1, -1.6 and 0.2 for income, mortgage interest rates and mortgage debt respectively.

expectations) and less so by household income and quantitative financial constraints. The apparent "de-linking" of house prices from income developments has been an issue of some speculation recently, when house prices continued to grow strongly in a number of EU countries even during the downturn in economic activity of the last few years of our sample. This was generally attributed to the changes in the financial system that should have made it easier for households to access external finance for a given (current) income and given availability of own-capital.[17] Similarly, the higher impulse effect of interest rates on house prices is along the lines of the argument put forward by Iacoviello and Minetti (2003) on the possible effects of financial liberalisation on the impact of interest rate shocks on house prices. To our knowledge, the reduction of the impulse effect of quantitative credit variables on house prices has not been noted in the literature, though one could rationalise this as a sign of credit constraints becoming less binding.

Before concluding, we comment briefly on the estimated coefficient of the lagged dependent variable, which in all models seems to have increased in the post-liberalisation period. We interpret this as a sign that in a world where households can enter/exit the mortgage and housing markets more easily and manage their portfolios, including their housing assets, more actively, house buying/selling decisions may more often be made with an eye to capital gains, than was the case in the past. If there are extrapolative elements in households' expectations, recent house price movements may feed more strongly into current housing demand decisions.

This interpretation is not the only one, but seems a plausible one and finds some support in the literature. Muellbauer and Murphy (1997) argued, in particular, that such behaviour could give rise to "frenzies" if there is a large number of speculative traders in the market. Following a similar approach to that paper, we could not detect evidence of "frenzies" in the sense used by Muellbauer and Murphy, but we do find evidence of a more complex dynamic adjustment in house prices in recent years.[18] In particular, while house price increases tended

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[17] This argument is not uncontroversial. For instance Almeida *et al* (2006) and Lamont and Stein (1999) find that the sensitivity of housing prices to household income changes is positively related to a relaxation of financial constraints. Following the former, we also interact the change in per capita real disposable income with the maximum loan-to-value (LTV) ratios which they use as proxy for financial liberalization. Results (not shown here but available upon request) show that the interaction term is statistically insignificant. This may be due to the different country sample which in our case is much more homogeneous but also to the quality of their financial constraint index.

[18] Following an earlier suggestion of Hendry (1984), Muellbauer and Murphy (1997) introduced a cubic function of the lagged house price increases to capture possible non-linearities due to such "frenzy" effects. In our model, when entering the second lag of the dependent variable in both linear and cubic form, they both turned out statistically significant in the more recent period but with opposite signs (the coefficient of the cubic

to be followed (ceteris paribus) by further increases in the two next years, extreme movements of house prices in one year (of over 15% positive or negative) tended to be followed by a reversal two years later. This could be a sign of a more complex household expectation mechanism (which interprets extreme movements as "bubbles") but it could also be for instance the result of supply catching up with demand shocks. Whatever the case, we think that the question of whether changes in the housing and mortgage markets have actually altered the way households make housing decisions and form their expectations of house prices is an interesting one and probably one that warrants further research.

V. Conclusions

The relation between financial factors and house price dynamics has been in the limelight in recent years. The observed interest rate channel is probably just one part of this relation. Typically, mortgage contracts make reference to more elements than the interest rate, all of which may affect the "effective" cost of mortgage debt and quantity constraints are not uncommon in this market. As argued in the first section of this paper, this suggests that, when modelling house price dynamics, one needs to, first, consider the credit quantity variables alongside the interest rate and, second, allow for differences in the short and long run effects of the two type of variables. Finally, one should consider the possibility that these relations may have changed over time as financial market liberalisation has progressed.

Relying on a standard single equation reduced form model, expanded to include supply side variables and deterministic country specific time trends, we find that, alongside with income and construction costs, (lagged) interest rates, mortgage debt and, to lesser degree, stock market developments have had a significant impact on short term house price dynamics in our sample of EU countries since the early 1970s. In the long run, the elasticity of (real) house prices with respect to (real) income is found to lie between 0.9 and 1.5, the semi-elasticity with respect to interest rates between -1.2 and –2.6. Mortgage debt seems also to enter in the long run relation, albeit with a relatively low elasticity (around 0.3).

When we split our sample to check for possible effects of financial liberalisation, we find that the relation between financial factors and house price dynamics is much more complex and

term is negative). Taking the point estimates literally, the model suggests that, for low house price increases/decreases, the effect of the cubic term roughly cancels out with the second lag of the dependent variable. For growth rates exceeding 15% (or below -15%), the overall effect becomes increasingly negative (positive).

less stable than what the initial models would seem to suggest. The changes between the two sub-periods concern mainly short-term dynamics and in general they are consistent with what one would expect the likely effect of financial liberalisation have been on house price dynamics.

In particular, the impulse effect on house prices of income and mortgage debt has become smaller, while that of interest rates, past increases of house prices and, to lesser degree, stock market has strengthened. In other words, there seems to have been a certain "de-linking" of short term house price dynamics from "real" income accompanied with a certain change whereby the housing market may have become more similar to a financial market, with interest rates and expectations of capital gains playing a more prominent role. It remains to be seen whether this change attracts more speculative traders in the market, in which case, as Muellbauer and Murphy (1997) argued, there could be more housing "frenzies" than was the case in the past in Europe.

From a policy point of view, it is also interesting to note that we find little evidence of important changes over time in the long run relation. Income growth seems to have continued dominating the long run path of real house prices, though it should be added that other factors, notably demographics and supply side variables, may also play an important role captured in our models by the country specific deterministic trends. In other words, financial liberalisation may have given the opportunity to households to "move up the housing ladder" earlier and, thus, anticipate their demand for housing services, but, the long run close relation of real house price rises and income growth seems to still hold true, "anchoring" as it were long run house price dynamics.

In conclusion, we think the question of whether changes in financial structures have affected house price dynamics and, in particular, whether the more favourable credit conditions have affected primarily the short term house price dynamics warrant further investigation. This paper puts an argument why this may be the case and provides some tentative results that support this hypothesis. Future research will probably need more reliable information on how credit standards may have changed over time as a result of structural changes in the mortgage markets and how these affected housing demand, housing prices and household expectations thereoff.

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Annex: Data

Data was collected from various international and national sources. One may find more information on these sources and data limitations in ECB (2003), where a large part of the same data set was used. We list below the main sources variable by variable and, in the case of house prices, country by country. The following abbreviations of sources are used: *Ameco*: European Commission Ameco database; *BIS*: Bank of International Settlements, *ECB/ESCB*: European Central Bank and European System of Central Banks (including individual National Central Bank data); *ESA95*: European System of Accounts 95; *HS*: National Agency for Entreprise and Housing, Denmark (see references); *IFS:* IMF International Financial Statistics; *NSI*: National Statistical Institute; *MEI:* OECD Main economic indicators; *OEO*: OECD Economic Outlook

<u>*Nominal House Prices (HP)*</u>

BE: *BIS* (based on real estate sector data)

DK: *NSI*

WG (DE): *ECB/ESCB* (based on real estate sector data) refers only to regions in ex-West Germany

IE: *BIS*, *ECB/ESCB* (based on data from the Department of Environment and Local Government)

ES: Ministry of Housing – prior to 1988 refers only to Madrid

FR: *ECB/ESCB*, National Sources (FNAIM and ECLN)

IT: *ECB/ESCB* (based on real estate sector data) - main cities.

NL: *ECB/ESCB*, Land Registry Office

FI: *NSI*

SE: *NSI*

UK: Real estate sector data

RHP is constructed deflating the nominal house price with the consumer price deflator (see below)

Consumer price deflator

Sources: Eurostat, ECB/ESCB, BIS. For Euro-area countries, we used HICP data, linked backwards to CPI, excluding the owner-occupied component. For DK, SE and UK we used CPI data. An alternative deflator based on the GDP deflator was also tried and led to practically the same results.

Nominal disposable income

Sources: *OEO*, *Ameco* and national sources. For Germany, data from regions in ex-West Germany was used. The real disposable income per capita (*RDIPC*) is constructed using the consumer price deflator and the total population aver 24 years of age.

Nominal mortgage interest rates

Sources: *ECB/ESCB*, *BIS* and national sources. For some countries, mortgage interest rates are not available for the 1970s. We have therefore linked the existing mortgage interest rate series with series on long term interest rates. The real mortgage interest rate (*RMRATE*) is constructed as the difference between the nominal mortgage rate and the *ex-post* inflation rate based on the consumer price deflator.

Long term interest rates

Sources: *OEO, MEI, BIS, ECB*. The basic definition refers to 10 year government bonds or the closest series we could find. For Spain from 1977 backwards we linked with the deposit short term interest rate. The real long term interest rate (*RLRATE*) is constructed as the difference between the nominal long term interest rate and the *ex-post* inflation rate based on the consumer price deflator.

Mortgage debt

Sources: ECB/ESCB, BIS, national sources. We use as main definition the end of period outstanding loans to households for house purposes. For missing data, we use the BIS "credits for domestic residential construction" data and also national source data with the closest possible definition. The real stock of mortgage debt per capita (*RMDEBT*) is constructed using the consumer price deflator and the total population aver 24 years of age.

Population statistics

Source: *Eurostat.* Data for Germany refers to the regions of ex-West Germany. *POP* is the total population above 24 years of age.

Housing Stock

The residential housing stock (HSTOCK) is calculated with the perpetual inventory method using residential investment data from *ESA 95* and *OEO*. Information on number of dwellings per country (Housing Statistics of the European Union, 2002) was used in order to calculate the "benchmark" (or initial) capital for each country. This was done comparing the change in the actual number of dwelling over a certain period and the residential investment over the same period (details available from the authors). We imposed 2% annual depreciation, but checked that small variations to this rate made no difference to the results**.** For Germany, we used data from ex-West Germany.

Construction costs

Various national sources, *ESA 95, OEO*. Where not available, the residential investment deflators were used instead (linked when necessary to the rest of the construction cost data). The alternative, of using throughout the residential investment deflators was tried and produced practically the same results. Real construction costs (*RCOST*) is calculated using consumer price deflator.

Stock exchange price index

BIS, IFS. The real stock price index *(RSP)* is constructed using the consumer price deflator.

Dates of Mortgage market measures according to ECB (2003) and Lacat and Messonier (2005).

Belgium (1977, 1995), Denmark (1982), Finland (1986, 1987), France (1987), Germany (1967), Ireland (1985), Italy (1983, 1988), Netherlands (1980, 1992), Spain (1987), Sweden (1985) and the U.K. (1980, 1986). The pre and post 'financial liberalization' (FL) period of Tables 6 is based on the date of the latest mortgage market measure.

Table 1 Panel Unit Root Tests

	RHP	*RDIPC*	*RMRATE*	*HSTOCK*	*POP*	*RSP*	*RMDEBT*	*RCOST*
Level								
No trends								
LLC	2.38	-1.47	0.69	3.26	-6.05**	1.18	2.68	-1.24
IPS	1.24	1.44	0.03	-1.41	0.10	1.25	5.87	-0.42
With trends								
LLC	2.56	-0.93	2.17	-1.32	2.28	-0.88	-1.30	-0.96
IPS	-1.18	-0.96	3.46	1.56	4.17	-1.23	-0.57	-0.50
First difference								
LLC	-4.84**	-7.19**	-10.72**	-2.35**	-0.92	-8.49**	-0.87	-7.10**
IPS	-5.32**	-7.53**	-12.20**	-0.91	-1.77**	-9.12**	-2.97**	-7.81**

Notes: *LLC* stands for the Levin, Lin and Chu tests in which it is assumed that there is a common unit root process. *IPS* stands for the panel integration tests are based on Im, Pesaran and Shin (2000). The lag order was set to 2 (1) for the unit root test in level (first difference). The tests are distributed asymptotically N(0,1) and are one-sided. (**) indicates the 5% significance level.

Table 2 Pedroni and Kao Cointegration Tests

	1	***2***	***3***	***4***	***5***
	RHP RDIPC RMRATE POP HSTOCK RCOST RMDEBT RSP	*RHP RDIPC RMRATE POP HSTOCK RCOST*	*RHP RDIPC RMRATE RMDEBT RSP*	*RHP RDIPC RMRATE RMDEBT*	*RHP RDIPC RMRATE*
	No Trends	*No Trends*	*No Trends*	*No Trends*	*No Trends*
Panel *v*	-0.34	0.76	0.44	1.31	3.43**
Panel ρ	2.89	1.13	1.26	0.01	-1.69**
Panel *pp-t*	0.10	-0.59	0.50	-0.55	-1.75**
Panel *t*	-0.29	0.31	0.82	-0.58	-1.59
Group ρ	3.51	2.07	2.08	1.00	-0.52
Group *pp-t*	-0.62	-0.33	0.85	0.06	-1.14
Group *t*	-1.72**	0.28	-0.18	-1.49	-1.97**
Kao *ADF*	-4.68**	-3.68**	-4.48**	-4.15**	-2.94**
	With Trends	*With Trends*	*With Trends*	*With Trends*	*With Trends*
Panel *v*	0.06	0.88	-0.15	0.20	1.96**
Panel ρ	3.62	1.53	2.55	1.64	-0.06
Panel *pp-t*	0.02	-1.11	1.63	0.81	-0.74
Panel *t*	-0.86	-2.68**	2.27	1.10	-0.84
Group ρ	4.31	2.65	3.28	2.38	1.05
Group *pp-t*	-0.90	-0.53	1.90	1.31	-0.11
Group *t*	-2.77**	-2.22**	1.00	0.30	-0.98

Notes: The null hypothesis for all tests is of no cointegration. All tests are distributed asymptotically N(0,1) and are one-sided. (**) indicates the 5% significance level. The Kao ADF test allows for fixed effects with no trends only. See Pedroni (1999) and Kao (1999) for details.

Table 3 House Price Equation – Alternative Specifications

	1	2	3	4
DRHP(-1)	0.53*** (0.06)	0.56*** (0.06)	0.43*** (0.06)	0.40*** (0.07)
DRDIPC	0.58*** (0.14)	0.54*** (0.15)	0.39*** (0.13)	0.36*** (0.14)
DRMRATE(-1)	-0.48*** (0.18)	-0.42** (0.18)	-0.36** (0.15)	-0.38** (0.16)
DRCOST	0.28*** (0.09)	0.27*** (0.09)	0.22*** (0.07)	0.20*** (0.07)
DRCOST(-1)	-0.22** (0.09)	-0.25*** (0.09)	-0.06 (0.07)	-0.07 (0.08)
DRMDEBT			0.49*** (0.11)	0.62*** (0.16)
DRSP			0.04*** (0.02)	0.03* (0.02)
RHP(-1)	-0.13*** (0.02)	-0.21*** (0.03)	-0.15*** (0.02)	-0.23*** (0.03)
RDIPC(-1)	0.13** (0.05)	0.15* (0.08)	0.19*** (0.06)	0.35*** (0.09)
RMRATE(-1)	-0.17 (0.12)	-0.32* (0.14)	-0.28*** (0.10)	-0.24* (0.12)
RMDEBT(-1)			0.03* (0.017)	0.07** (0.03)
RSP(-1)			0.002 (0.001)	0.01 (0.01)
POP(-1)	0.37*** (0.12)	0.44 (0.29)	-0.02 (0.15)	0.41 (0.30)
HSTOCK(-1)	-0.18* (0.10)	-0.18 (0.15)	-0.05 (0.11)	-0.12 (0.17)
RCOST(-1)	0.01 (0.02)	0.07 (0.05)	-0.04 (0.03)	-0.03 (0.06)
Long-Run Elasticities				
RDIPC	1.0	0.7	1.3	1.5
RMRATE	-1.3	-1.5	-1.9	-1.0
RMDEBT			0.2	0.3
RSP			0.01	0.4
POP	2.8	2.1	-0.1	1.8
HSTOCK	-1.4	-0.9	-0.3	-0.5
RCOST	0.1	0.3	0.3	-0.1
Estimation Method	OLS	OLS	IV-2SLS	IV-2SLS
Country Trends	no	yes	no	yes
R- squared	0.46	0.49	0.59	0.62
Obs	358	358	334	334
Autocorrelation	6.4	5.3	2.3	3.2

Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV = instrumental variables. DRMDEBT is instrumented with DRMDEBT(-1). The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively.

Table 4 House Price Equation: Robustness of 'Preferred' Specification

	1	*2*	*3*	*4*
DRHP(-1)	0.43*** (0.06)	0.41*** (0.06)	0.50*** (0.07)	*0.42*
DRDIPC	0.37*** (0.13)	0.40*** (0.13)	0.40*** (0.16)	*0.33*
DRMRATE(-1)	-0.38** (0.15)	-0.41*** (0.15)	-0.41*** (0.15)	*-0.09*
DRCOST	0.23*** (0.07)	0.21*** (0.07)	0.18** (0.07)	*0.18*
DRMDEBT	0.47*** (0.09)	0.59*** (0.12)	0.41** (0.19)	*0.41*
DRSP	0.05*** (0.015)	0.03** (0.014)	0.04** (0.01)	*0.02*
RHP(-1)	-0.15*** (0.02)	-0.24*** (0.03)	-0.24*** (0.03)	-0.25*** (0.05)
RDIPC(-1)	0.14*** (0.05)	0.36*** (0.09)	0.29*** (0.09)	0.37** (0.15)
RMRATE(-1)	-0.30*** (0.11)	-0.27** (0.12)	-0.33** (0.13)	-0.66*** (0.23)
RMDEBT(-1)	0.03** (0.01)	0.07*** (0.02)	0.07** (0.03)	0.05 (0.04)
Long-Run Elasticities				
RDIPC	0.9	1.5	1.2	1.5
RMRATE	-2	-1.1	-1.4	-2.6
RMDEBT	0.2	0.3	0.3	0.2
Estimation Method	IV-2SLS	IV-2SLS	IV-2SLS	IV-PMG
Individual trends	no	yes	yes	yes
R- squared	0.59	0.63	0.65	0.66
Obs	334	334	329	334
Autocorrelation	1.5	1.8	1.5	12.6

Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV-2SLS = instrumental variables two stage least square. *DRMDEBT* is instrumented with *DRMDEBT(-1)*. The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively. The last column shows the results of the Pooled Mean Group (PMG) model with country-specific short-run dynamics, whose simple average is shown in *italics*.

Table 5 House Price Equation: Splitting the Sample Period

	1		*2*	
	Pre-1990	Post-1990	Pre-1990	Post-1990
DRHP(-1)	0.37*** (0.08)	0.63** (0.11)	0.35*** (0.08)	0.59* (0.12)
DRDIPC	0.52** (0.18)	0.06 (0.20)	0.48** (0.20)	0.12 (0.21
DRMRATE(-1)	-0.37** (0.18)	-0.60** (0.28)	-0.39** (0.19)	-0.68* (0.37)
DRCOST	0.25*** (0.08)	0.18 (0.15)	0.25** (0.09)	0.15 (0.14
DRMDEBT	0.64** (0.14)	0.04 (0.21)	0.77*** (0.17)	0.13 (0.24
DRSP	0.05** (0.02)	0.04** (0.02)	0.03 (0.02)	0.04** (0.02)
RHP(-1)	-0.17*** (0.03)	-0.17*** (0.03)	-0.24*** (0.03)	-0.24*** (0.03)
RDIPC(-1)	0.21*** (0.05)	0.20*** (0.05)	0.37*** (0.09)	0.37*** (0.09)
RMRATE(-1)	-0.43** (0.15	-0.46* (.28)	-0.33* (0.17	-0.64* (0.33)
RMDEBT(-1)	0.06*** (0.017)	0.05*** (0.017)	0.08*** (0.03)	0.07** (0.03)
Long-Run Elasticities				
RDIPC	1.2	1.2	1.5	1.5
RMRATE	-2.5	-2.7	-1.4	-2.7
RMDEBT	0.4	0.3	0.3	0.3
Estimation Method	IV-2SLS		IV-2SLS	
Individual trends	no		yes	
R- squared	0.59		0.61	
Obs	334		334	
Autocorrelation	2.1		3.2	

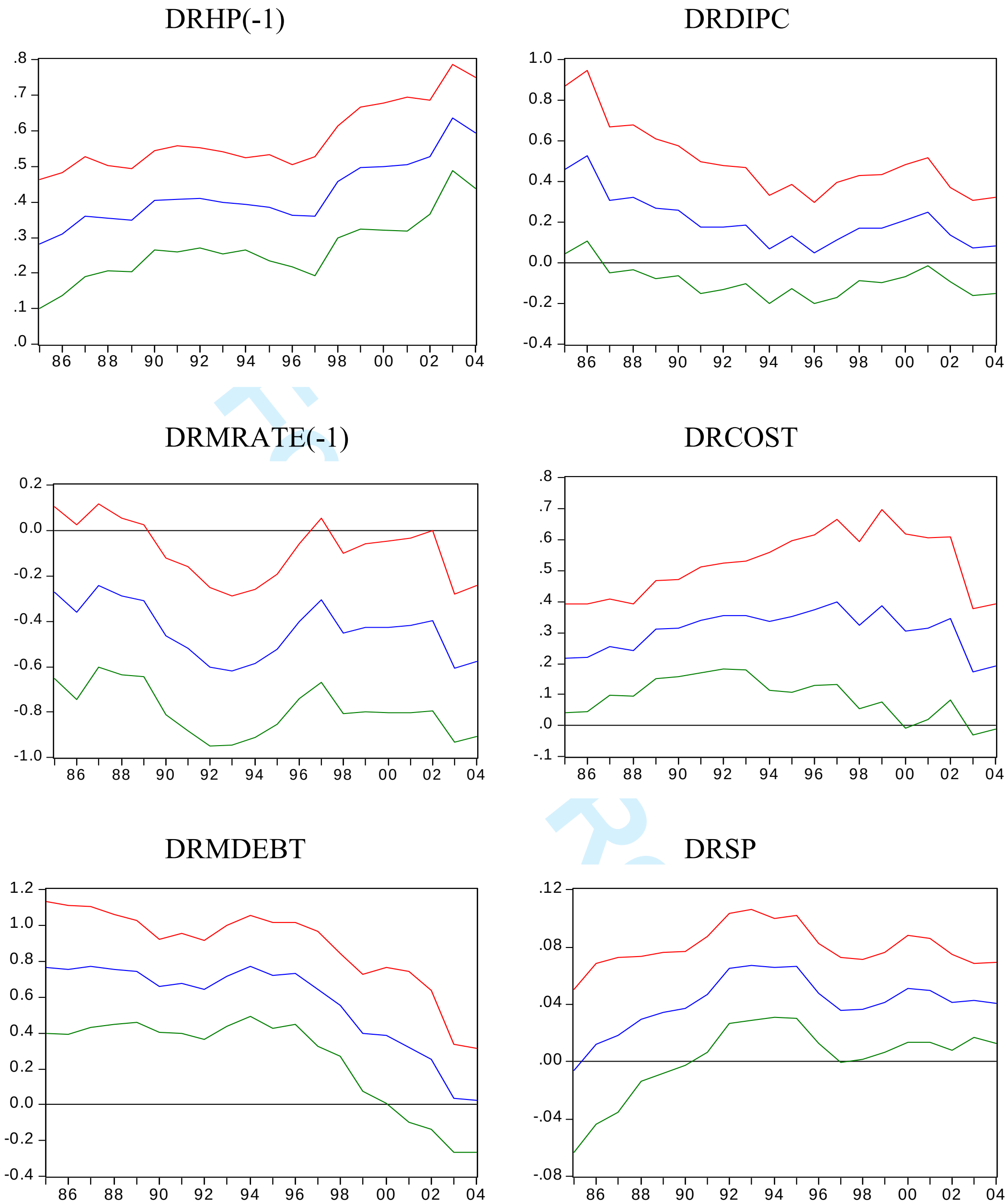
Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV-2SLS = instrumental variables two stage least square. *DRMDEBT* is instrumented with *DRMDEBT(-1)*. The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively.

Table 6 House Price Equation: Additional Results

	1	*2*	*3*	*4*
	Pre-1990	Post-1990	Pre-FL	Post-FL
DRHP(-1)	0.36*** (0.09)	0.59*** (0.10)	0.31*** (0.10)	0.49*** (0.09)
DRDIPC	0.44** (0.21)	0.08 (0.15)	0.62** (0.24)	0.11 (0.16)
DRMRATE(-1)	-0.37* (0.22)	-0.58*** (0.21)	-0.29 (0.22)	-0.42** (0.21)
DRCOST	0.23** (0.10)	0.19 (0.12)	0.15 (0.10)	0.30 (0.14)
DRMDEBT	0.71*** (0.18)	0.02 (0.18)	0.73*** (0.22)	0.39** (0.18)
DRSP	0.03 (0.03)	0.04** (0.02)	-0.01 (0.03)	0.05** (0.02)
ECM(-1)	-0.20*** (0.04)	-0.19*** (0.03)	-0.31*** (0.05)	-0.15*** (0.03)
Estimation Method	IV-2SLS	IV-2SLS	IV-2SLS	IV-2SLS
Individual trends	no	no	no	no
R- squared	0.53	0.70	0.50	0.64
Obs	169	165	130	204
Autocorrelation	5.2	0.3	5.1	2.8

Notes: All regressions include fixed effects. Heteroskedasticity-corrected standard errors are in brackets below the point estimates. * = significance at the 10% level, ** = significance at the 5% level, *** = significance at the 1% level. IV-2SLS = instrumental variables two stage least square. *DRMDEBT* is instrumented with *DRMDEBT(-1)*. Pre-FL and post-FL refer to the split the sample according to the country-specific "dates of financial liberalization" measures discussed in the Annex. The serial correlation test is distributed as a χ^2 with 2 degrees of freedom and the 10% and 5% critical values are 4.61 and 5.99, respectively.

Figure 1: Rolling Regressions: Short Run Coefficients of House Price Equation



Notes: Rolling regressions of preferred specification with imposed long run relationship as in columns 1 and 2 of Table 5. The rolling window is fixed at T=15. The middle blue line is the point estimate of the correspondent coefficient. Confidence bands are based on ± 1.6 standard errors.